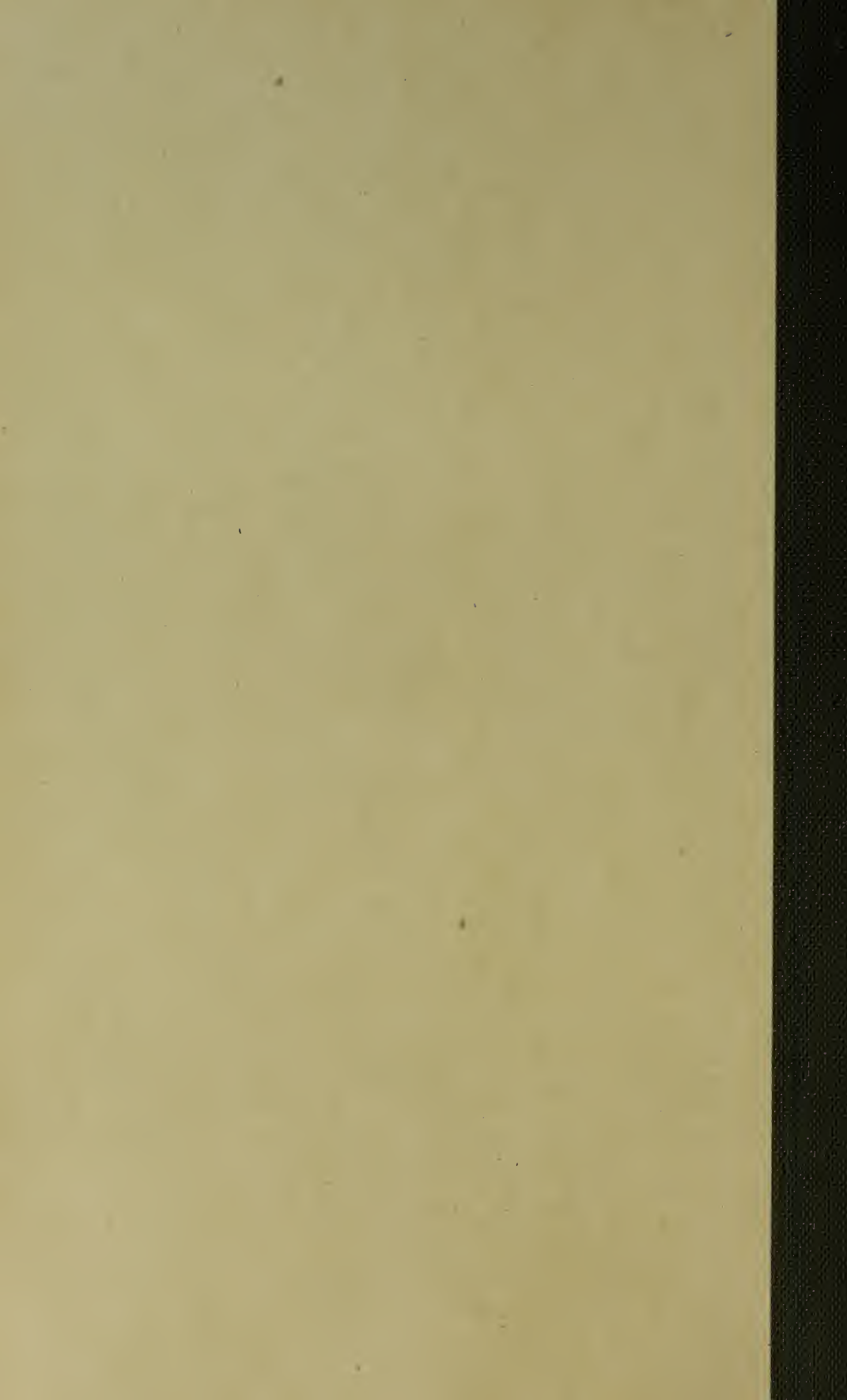


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REGIONAL DIFFERENTIATION IN THE
INDUSTRIAL STRUCTURE OF JAPAN

BY

OIVA TUOMINEN

HELSINKI

1966

Presented the 17th of September 1965
by Veikko Okko and Olavi Granö

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FOREWORD

In 1961 one of my greatest hopes, to visit Japan, came true. For four months, from midwinter to early summer, I had the chance to travel in different parts of the country, at all levels of altitude, from Nagasaki in the south-west to Wakkanai in the north.

Although Japan has more than 20 times as big a population as Finland, which has an area of similar size, the industrial structures of the two countries resemble each other to some extent. Due to this, among other things, it was interesting to study the industrial structure of Japan following the same methods as had been used earlier in Finland. I even hope that my attempts to examine different parts of the country have diminished a number of misleading deductions.

In this study I have used the printed statistical material of the 1955 population census of Japan almost exclusively. The last part of the census had just appeared when I left Japan. Only preliminary information of the 1960 census was then at hand.

I found it very agreeable to work in Japan, thanks to the kind helpfulness that I met everywhere. Among the numerous institutions that have kindly helped me, I want to mention especially the Bureau of Statistics, the Geographical Survey Institute and the Institute of Population Problems. Of the private persons who gave me their advice, I would like to mention above all Professor Dr. Shinzo Kiuchi, who showed me great kindness and allowed me to work at the Institute of Human Geography, University of Tokyo.

The reader will notice that references have been omitted from the text, but a list of publications which have been consulted and have proved useful in the preparation of this study can be found in the bibliography at the back.

The figures and the appended map have been drawn by Mrs. Leena Kiiskilä. The translation into English has been made by Mrs. Brita Ohlson and revised by Mr. Donald Fields.

Department of Geography, University of Turku, May 1965

Oiva Tuominen

1. POPULATION AND AREAL UNITS

The area covered by the 1955 census is identical with the area strictly under the administrative authority of the Japanese government at the time of the census. It comprises 369,661 square kilometers (rivers, lakes and inlets included).

On October 1, 1955 (the enumeration date for the census) the total number of inhabitants of this area was 89,275,529, or 242 persons per square kilometer. Great regional contrasts characterized the distribution of the population. The biggest prefecture, Hokkaido, which comprises 21.2 % of the total area of Japan, had only 5.3 % of the total population (density 61). The third smallest prefecture, Tokyo-to, which comprises only 0.5 % of the total area, contained 9.0 % of the population (density 3,973). It can be estimated that about half of the inhabitants of Japan live in an area that is only about 5 % of the total. The regional contrasts are sharpened constantly as the movement from the sparsely populated areas to the densely populated ones is still going on.

Fig. 1 shows the most essential regional features of population density. In most parts of Hokkaido density is less than 100. Further towards the south the sparsely populated area becomes more discontinuous and surrounds the densely populated district of the Inland Sea like a broken chain. The most densely populated areas are found in a narrow belt orientated ENE—WSW.

Of the population 49.1 % were males, which means 966 males per 1,000 females. In the age classes up to 20 years males were in a majority, and above 20 years females, with the exception of the 49 year and 51—58 year classes. The prefectures of Hokkaido, Tokyo-to and Kanagawa-ken had a majority of males, as had most of the wards in the six biggest cities. The rural areas having a majority of males were mostly sparsely populated forestry districts.

The number of employed persons was 39,261,351, or 44.0 % of the total population and 66.0 % of persons aged 15 and over. Of the employed persons 60.9 % were males, which means 1,555 employed males per

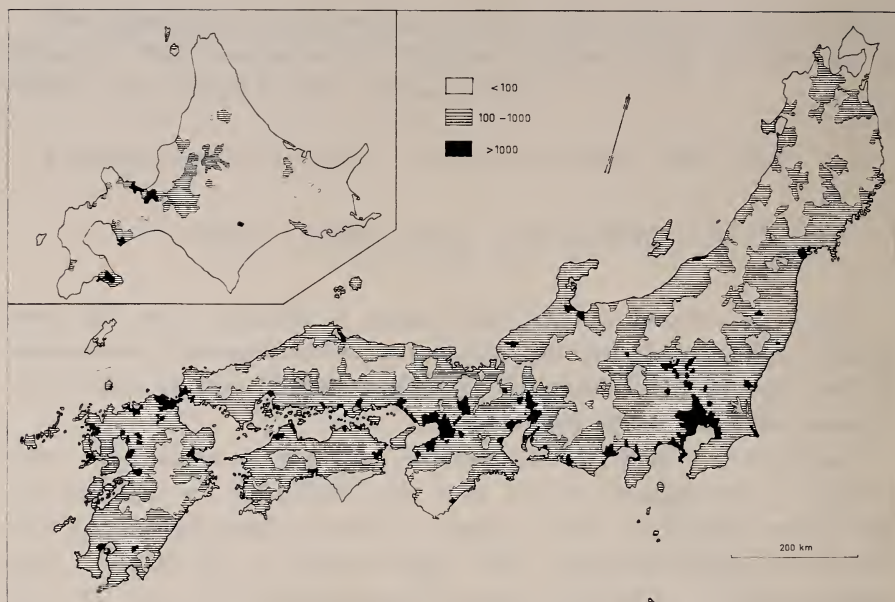


Fig. 1. Distribution of population. Inhabitants per km².

1,000 employed females. Of the males aged 15 and over 83.3 % were employed, of the corresponding female age groups 49.9 %.

Agriculture, and thus the whole of primary industry, had an absolute majority of females. The groups of trade, finance etc. and services etc. had relatively more females (of all females employed) than males (of all males employed).

Japan is divided into 46 prefectures (42 *ken*, 2 *fu*, 1 *to* and 1 *do*). Each prefecture is divided into *shi* (cities) and *gun* or *shicho* (rural counties) respectively 491 and 536 in number in 1955. The *gun* and *shicho* are further divided into *machi* or *cho* (towns) and *mura* or *son* (villages), of which there were altogether 4,322. *Shi*, *machi* (*cho*) and *mura* (*son*) are political units, *gun* (*shicho*) are merely administrative subdivisions of the prefectures.

The major cities, Tokyo, Osaka, Nagoya, Kyoto, Yokohama and Kobe, are subdivided into *ku* (wards), totalling 84.

In this study the *shi* and *gun* have been used as areal units for Japan Proper (Old Japan, including Honshu, Shikoku and Kyushu). Their average area is 293 square kilometers and the average number of inhabitants 85,098. In Hokkaido the average area of the correspon-

ding districts (*shi* and *shicho*) is 2,309 square kilometers — much bigger, as can be seen. The *shi* in Hokkaido are as big as the *shi* of Japan Proper on the basis of the average number of inhabitants, whereas the *shicho* are more populous, the average number of inhabitants for both together being 140,385. If the same units had been used for the description of the regional features of the population of Hokkaido as those for Japan Proper, Hokkaido would have been treated in a much more general way than Japan Proper. Therefore the *cho* and *mura* have been used instead of the *shicho* for Hokkaido. Thus the units for Hokkaido are of the same size category as those for Japan Proper, i.e. they have an average area of 319 square kilometers. Their average number of inhabitants is 19,403.

As there still remain units too big to fit into this division (the biggest cities), these have been treated using the *ku* as units. Thus in this study, the whole of Japan has been divided into 1,317 districts (485 *shi*, 84 *ku*, 522 *gun*, 112 *cho* and 114 *mura*). They have an average area of 281 square kilometers (the smallest 3, the biggest 2,400) and their average number of inhabitants is 67,787 (the smallest 1,676, the biggest 568,498).

2. MAIN TYPES OF INDUSTRIAL STRUCTURE

According to the census of 1955 the employed persons aged 15 and over were distributed among the various industry groups as follows:

Industry group	Employed persons	Percent
All industries	39,261,351	100.0
(A) Primary industry	16,111,216	41.0
(1) Agriculture	14,890,288	37.9
(2) Forestry etc.	518,725	1.3
(3) Fisheries etc.	702,203	1.8
(B) Secondary industry	9,219,905	23.5
(4) Mining	535,195	1.4
(5) Construction	1,782,551	4.5
(6) Manufacturing	6,902,159	17.6
(C) Tertiary industry	13,930,230	35.5
(7) Trade etc.	6,095,401	15.5
(8) Transportation etc.	2,048,035	5.2
(9) Services etc.	5,786,794	14.7

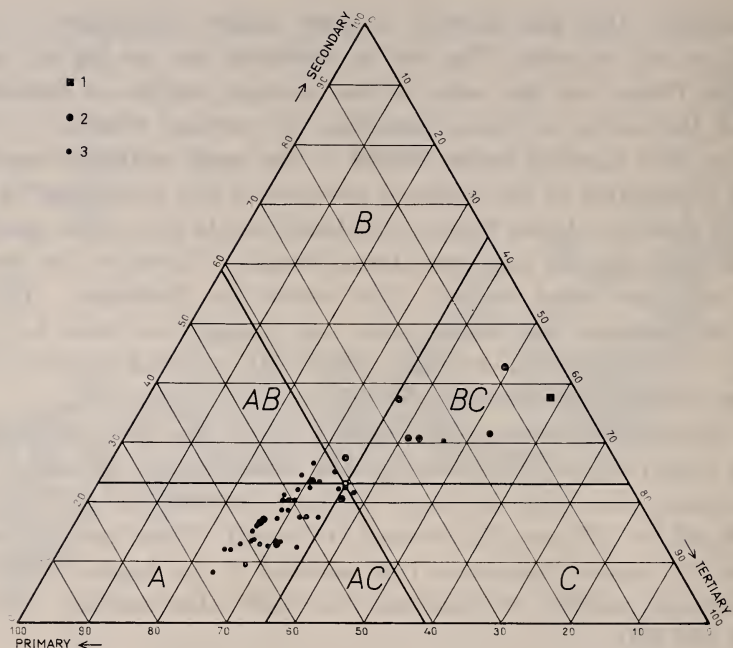


Fig. 2. Industrial structure of the *ken* (prefectures). 1. Over 3 mill., 2. 1—3 mill., 3. under 1 mill. employed persons.

This classification corresponds the census so that the minor groups 1—6 correspond to classes I—VI in the census, group 7 corresponds to classes VII and VIII (wholesale and retail trade, finance, insurance and real estate), group 8 to class IX (transportation, communication and other public utilities, i.e. electric, gas, water and sanitary services) and group 9 to classes X—XII (services, government and not classifiable). Persons not classifiable amount to no more than 2,225 or 0.01 %.

Fig. 2 shows how the prefectures of Japan can be placed into a triangular graph, whose co-ordinates are the percentages of each of the three major industry groups. This graph also shows the average for the whole country (primary industry 41.0, secondary industry 23.5 and tertiary industry 35.5), and lines parallel to the sides of the triangle have been drawn through this point, dividing it into six fields. In field A¹ the percentage of primary industry (A) is bigger than the aver-

¹ An italic A denotes a field of the triangle or the corresponding group of districts or the type of industrial structure; an ordinary A denotes the industry group.

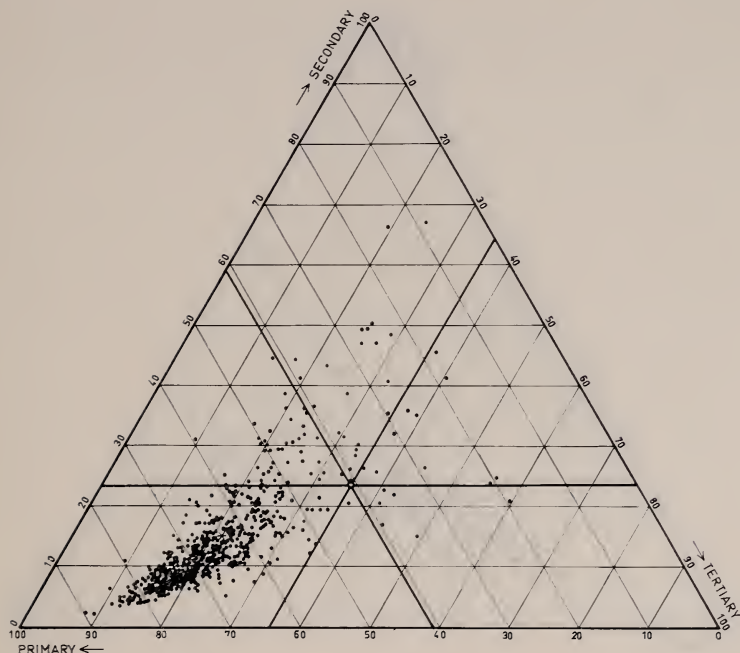


Fig. 3. The *gun* (rural counties) of Japan Proper. The average industrial structure is indicated by an asterisk.

age for Japan, whereas in *B* the percentage of secondary industry (*B*) is bigger than the average, in *AB* the percentage of both of them is bigger than the average, etc.

The points representing the prefectures form a long and narrow group, the range of variation being largest for primary industry (63.8 %) but only about half of this for secondary and tertiary industry (34.4 % and 35.0 % respectively). All the prefectures comprising the seven biggest cities (present Kitakyushu-shi included) are found in field *BC*, because the percentage of their primary industry is smaller than the average, whereas that of the two other major groups is bigger than the average. The percentage of primary industry is smallest in Tokyo-to (4.0 %) and biggest in the southernmost prefecture of Kagoshima-ken (67.8 %). In the latter the percentage of secondary industry is for its part smallest (8.4 %), whereas in Osaka-fu it is biggest (42.8 %). Tertiary industry has its smallest percentage in Ibaraki-ken (23.6 %) and its highest in Tokyo-to (58.6 %). Nara-ken lies almost at the point

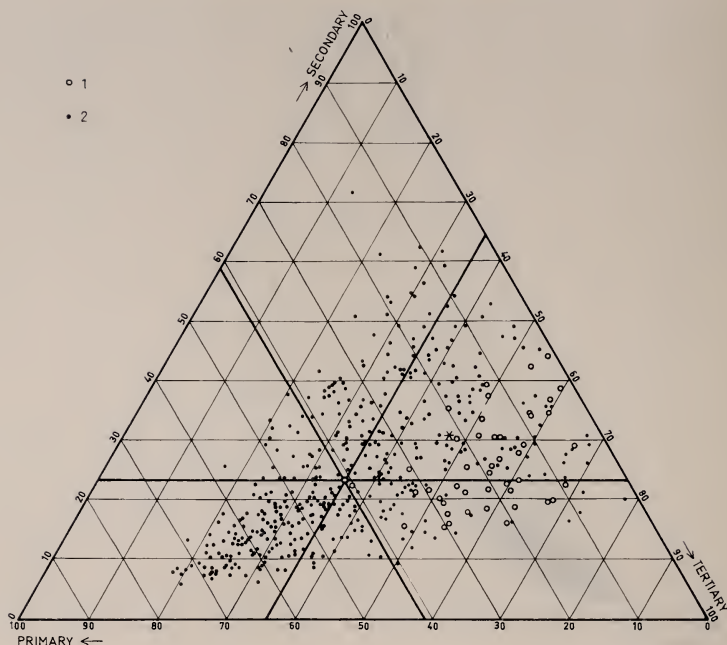


Fig. 4. The *shi* (cities) of Japan Proper. 1. Prefectural capital, 2. other city.

of mean value and could thus be said to represent average conditions in Japan in this respect.

Fig. 3 shows the distribution of the 522 *gun* of Japan Proper in the triangle. The points have spread themselves over a somewhat large area, but unevenly, so that by far the largest part of them is in field A, where the percentage of primary industry exceeds the average for Japan and that of the two other major groups falls below it. The percentage of secondary industry much more often exceeds the average than does that of the tertiary industry. Only one district has fallen into field AC. This is, however, quite near the point of mean value.

Correspondingly Fig. 4 shows the industrial structure of the *shi* of Japan Proper. Its 465 points have spread themselves over a larger area and more evenly than the former. The percentages of primary and tertiary industry only seldom exceed 70, that of secondary industry only seldom amounts to more than 60. The percentage of secondary industry always exceeds 5, and that of tertiary industry falls below

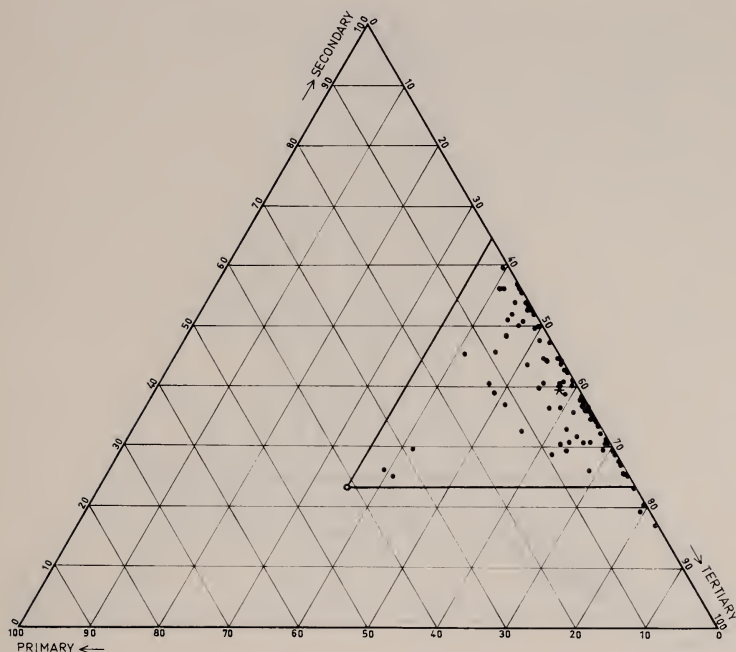


Fig. 5. The *ku* (wards) of the six major cities.

20 only in exceptional cases. The capitals of the prefectures group themselves within a somewhat restricted area down on the right. For all of them, the percentage of primary industry always falls below and that of tertiary industry always exceeds the average. The percentage of secondary industry varies over and under the average.

Fig. 5 shows the industrial structure of the 84 *ku* of Tokyo, Osaka, Nagoya, Kyoto, Yokohama and Kobe. Nearly all of them are in field BC. In half of them the percentage of primary industry is smaller than 1. The biggest primary industry percentages are to be found on the outskirts of the cities. The three wards differing most from the others are Tarumi-ku in Kobe and Kohoku-ku and Totsuka-ku in Yokohama. Their population density is less than 1,000, i.e. exceptionally small.

Fig. 6 shows the industrial structure of the 246 districts (*shi*, *cho* and *mura*) of Hokkaido. The distribution of the points resembles the one that would result if the *shi* and *gun* of Japan Proper were placed into one triangle. Hokkaido turns out to be a sort of miniature of Japan

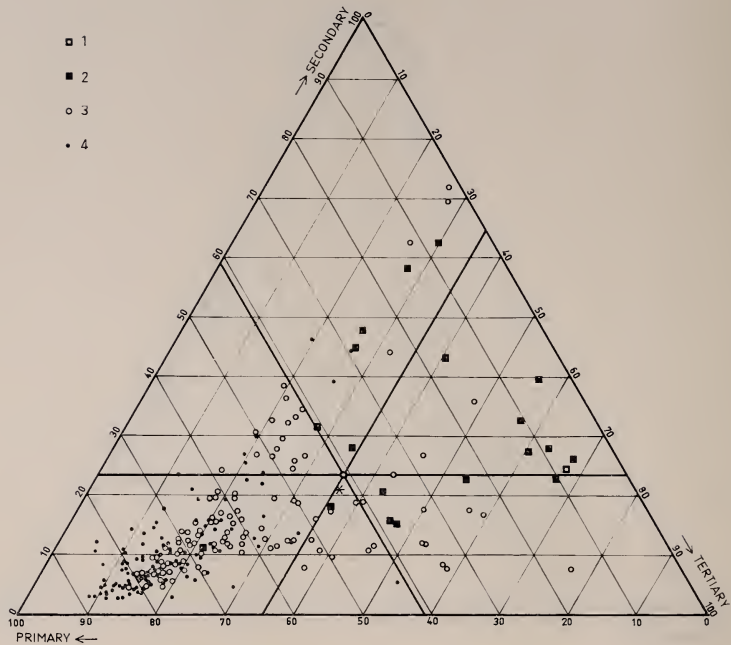


Fig. 6. Hokkaido. 1. Sapporo, 2. other *shi*, 3. *cho* (town), 4. *mura* (village).

Proper. The average, too, is close to that for Japan Proper. The *shi* are situated on the right and the *mura*, representing the most rural districts, on the left. Of the *shi*, Shibetsu forms an exception, as its primary industry has a percentage of 67.2. Of the *cho*, on the one hand Utashinai and Kamisunagawa, where secondary industry has a percentage of 71.1 and 69.3 respectively, and on the other hand Chitose, where the percentage of tertiary industry amounts to as much as 76.7, are exceptions.

As an example of the prefectures of Japan Proper and as a point of comparison with Hokkaido, Fig. 7 shows the corresponding districts of Aichi-ken, the *shi*, *cho* and *mura*, 127 in number, about half the number of Hokkaido districts. The group of points turns more sharply up to the right than that for Hokkaido, which is mostly due to the greater percentage of secondary industry. That the average percentage of tertiary industry is still almost equal to that of Hokkaido is due to the fact that the capital, Nagoya, differs considerably from the other districts with regard to industrial structure.

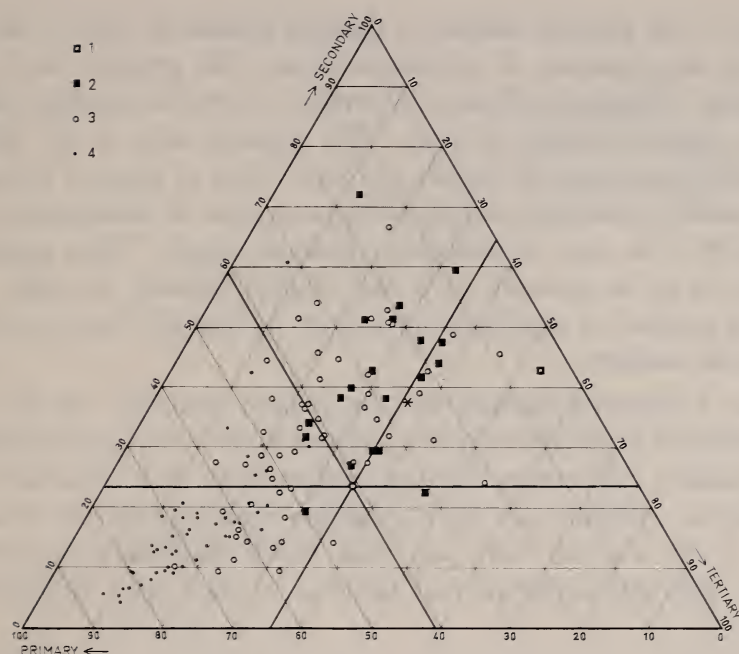


Fig. 7. Aichi-ken. 1. Nagoya, 2. other shi, 3. cho, 4. mura.

The units of this study, 1,317 in number, fall into the six fields of the triangle (which correspond to the main types of industrial structure) as follows:

Type	Gun ¹	Shi	Ku	All districts	Population %	Area %	Population per km ²
A	614	144	—	758	42.0	78.1	130
AB	67	26	—	93	5.0	7.3	164
B	31	76	—	107	7.5	4.1	435
BC	10	141	80	231	33.5	4.7	1,717
C	16	65	4	85	10.0	3.9	626
AC	10	33	—	43	2.0	1.9	261
Total	748	485	84	1,317	100.0	100.0	242

¹ cho and mura for Hokkaido.

As can be seen from this table, which also shows the population and area expressed as a percentage and the population density of each group, the most important types are A and BC, which contrast with one

another. The greatest number of districts belongs to type *A*; the sum total of their number of inhabitants is also the greatest, as is their total area. Population density, however, is here the smallest, and so is the relative number of cities. The average area of the districts is greater than in any of the other groups. Next to group *A* as regards the number of districts, as well as the sum total of inhabitants, comes group *BC*. Its area is, however, relatively small. Thus population density is at its greatest as is the relative number of cities. The average number of inhabitants is greatest in type *BC*, but the average area is the smallest.

The *A* districts, characterized by primary industry, are the most rural districts in this classification, whereas the *BC* districts characterized by secondary and tertiary industry represent the most urbanized types of districts. Although all the *shi* together represent the *BC* structure, most of the *shi* that have less than 50,000 inhabitants resemble so closely the rural landscape that taken as a whole they correspond to type *A*.

The *B* districts, characterized by secondary industry, can be considered a sort of middle group as regards the number of inhabitants and the area. The average population density is bigger still in the *C* districts, which are characterized by tertiary industry. Groups *AB* and *AC* are heterogeneous intermediary forms between the *B* and *C* groups and the *A* group.

To give a general picture of the distribution of all the districts according to industrial structure, they have been marked with numbers in Fig. 8. With its clearly distinguishable maximum, the cluster of points represented by the numbers is somewhat reminiscent of a comet as regards the density variations. The growth of density to the right of the triangle is due to the *ku*. There are units in 73 of the triangle's 100 meshes. More than half of the districts (52.5 %) are in nine adjacent meshes. The dispersal of the units is thus quite considerable, which can be regarded as an advantage from the point of view of classification.

In a study about the regional variations of Finland's industrial structure (Tuominen 1954) the writer has already explained the basis of the classification system used above, in which the average industrial structure of the whole country plays a decisive role. This sys-

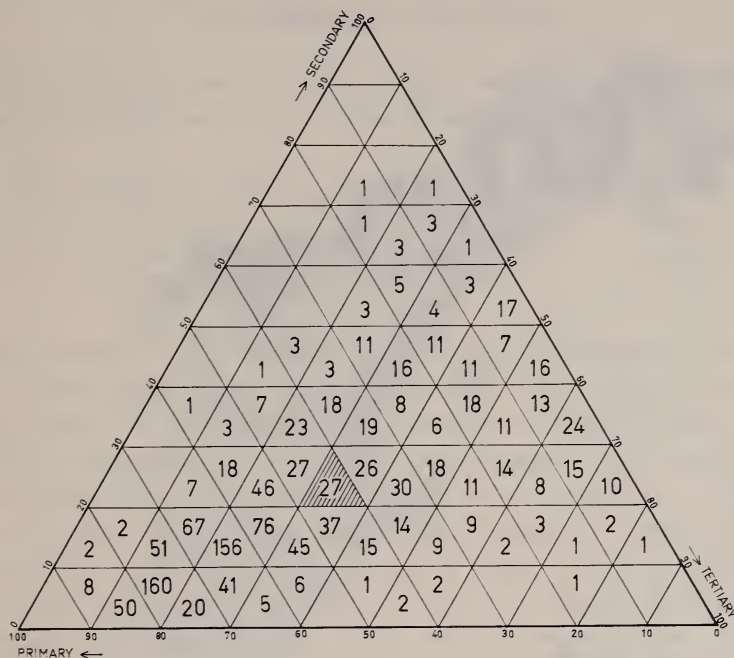


Fig. 8. All districts. The mean value in the shaded mesh.

tem fulfils many demands that other corresponding systems generally do not. The most important of these conditions are the following: 1. classification must be such as gives each of the observed components of the industrial structure its due weight. 2. The classification must be applicable to all district units, whatever their size and quality. 3. It must be applicable to general as well as detailed classification. 4. It must show the characteristic regional differences.

If the changes in the industrial structure are to be observed during some period of time, this system of classification, in which the point of reference (the average for the whole country) is constantly changing, does not show the 'absolute' changes in the industrial structure of each of the units. However, it shows much more easily the 'relative' changes that take place in the relations between the units within these units taken as a whole. This is the specific quality and advantage of the 'dynamic classification' as compared with the 'static classification'.

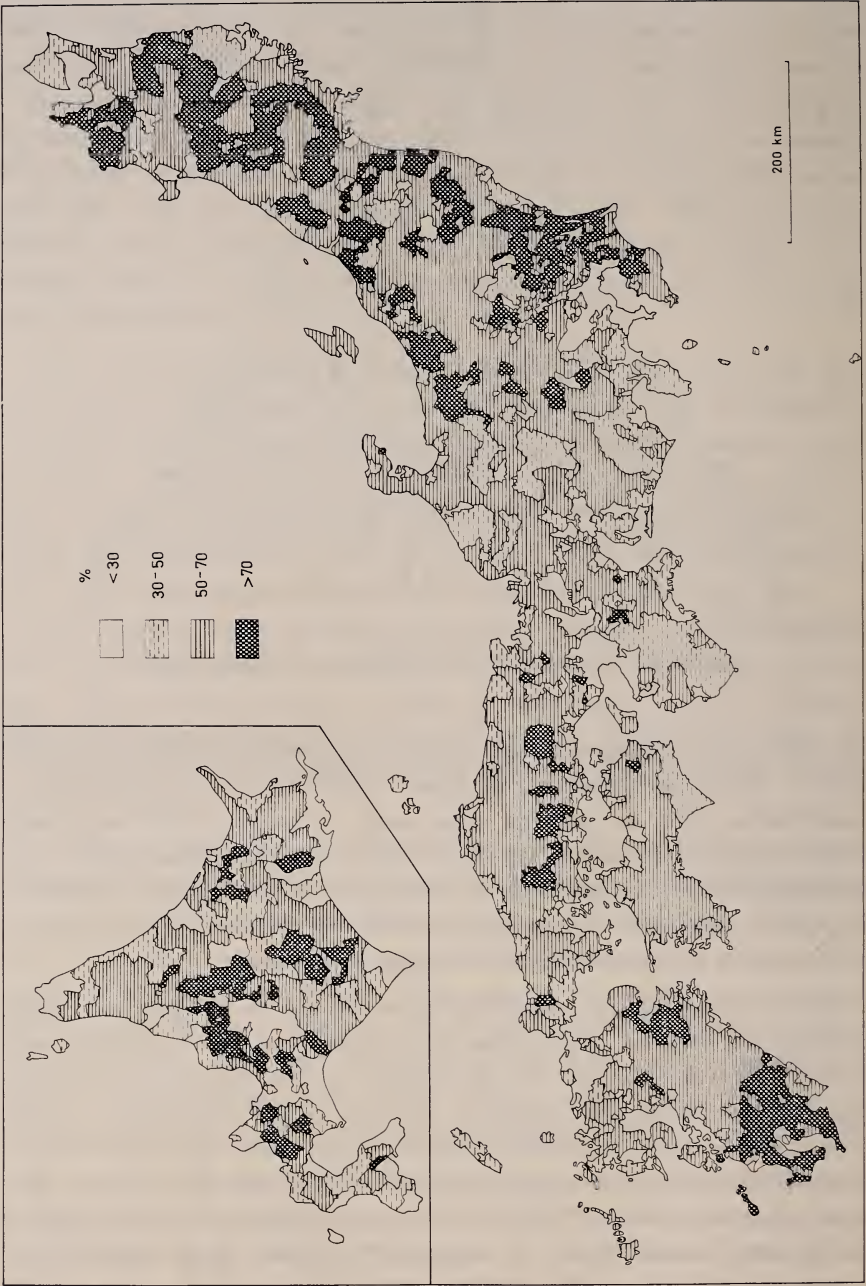


Fig. 9. Agriculture as a percentage of all industries.

3. PRIMARY INDUSTRY

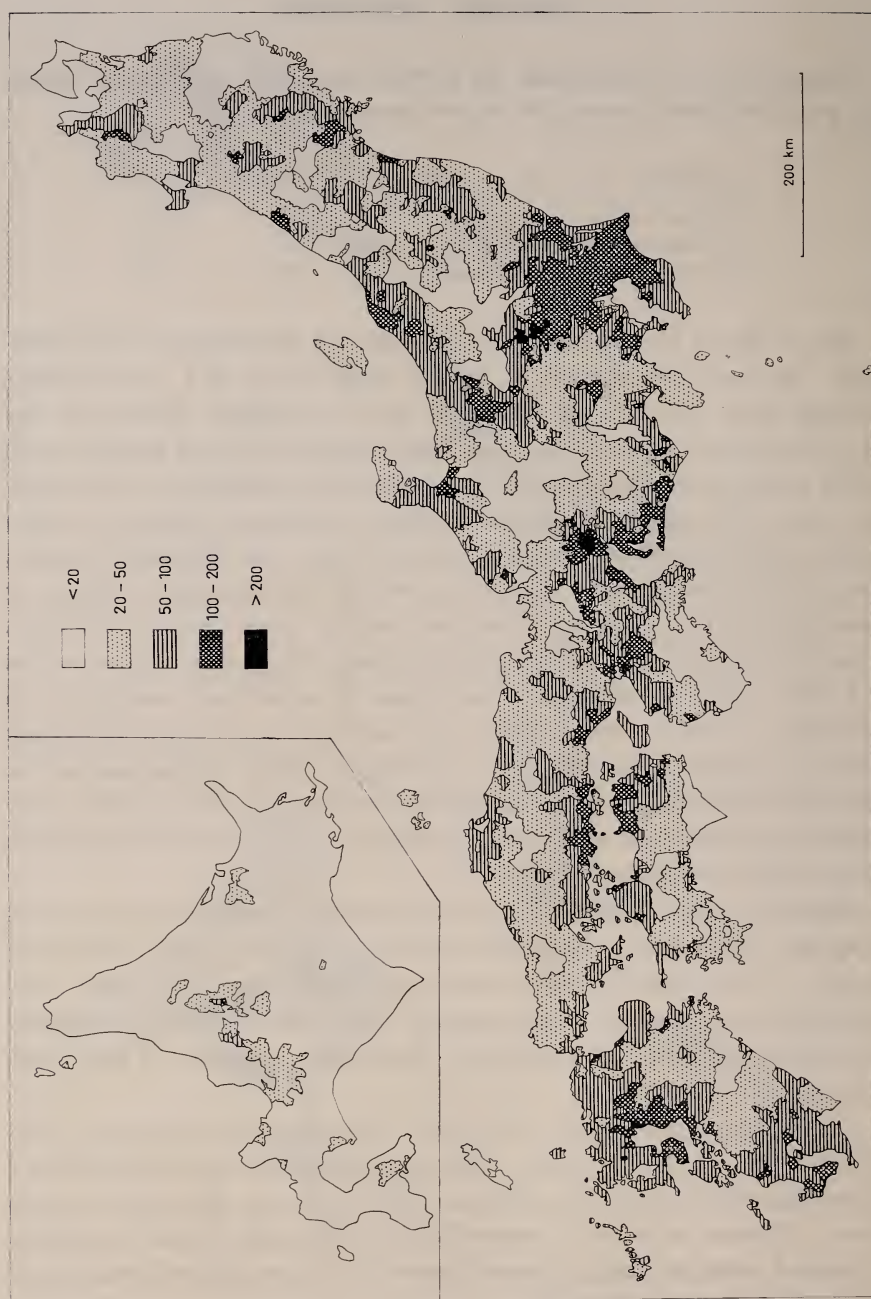
Expressed as a percentage the persons employed in primary industry are distributed among the minor groups as follows:

(A) Primary industry	41.0	100.0
(1) Agriculture	37.9	92.4
(2) Forestry and hunting	1.3	3.2
(3) Fisheries and aquiculture	1.8	4.4

Fig. 9 shows for each district agriculture's percentage of all industries. In the 1,317 districts it ranges from 0.0 to 89.1. Percentages of more than 70 occur in Hokkaido and in northern Honshu as far as a line between Sagami Nada and Toyama Bay and in the interior north of the Inland Sea. They also occur in Kyushu, especially in the southern part of the island. Large percentages of persons employed in agriculture occur in rather sparsely populated areas. In Hokkaido they are found only exceptionally in districts where the population density is more than 100 per square kilometer, and in Japan Proper (northern Honshu excluded) generally in districts where the density is between 100 and 300. Small percentages of less than 30 occur very irregularly in Hokkaido; in Japan Proper they occur mostly in the densely populated districts, especially in and near the biggest cities. Expressed as an inversion, in the sparsely populated districts agriculture includes a very variable percentage of all persons employed, while in densely populated districts this percentage is small.

However, the number of persons employed in agriculture per areal unit (Fig. 10) generally accords with the variations of the population density. The largest values occur especially near the great concentrations of population. In sparsely populated districts, the density of persons employed in agriculture shows the variation of their percentages more clearly.

Agriculture's percentage of primary industry was 92.4 (range 1.6—100) for the whole of Japan. This percentage was more than 95 for more than two-thirds of the districts. Fig. 11 shows the regional variations. Primary industry is generally still more agricultural in densely populated districts than in sparsely populated ones, where forestry etc. is relatively more important.

Fig. 10. Persons employed in agriculture per km².

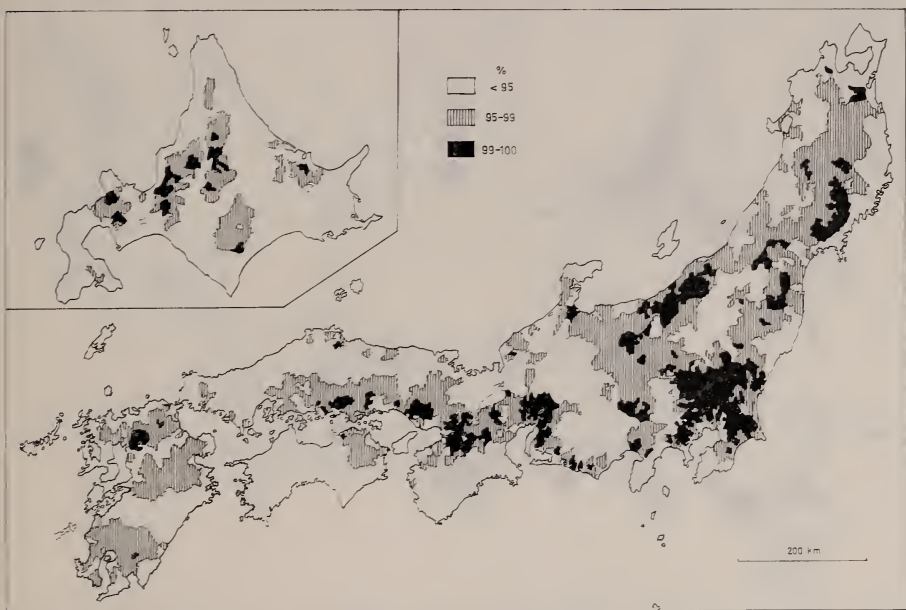


Fig. 11. Agriculture as a percentage of primary industry.

It has been stated earlier that in Japanese agriculture females form both an absolute and a relative majority. In manufacturing districts, however, the percentage of males employed in agriculture, compared to the sum total of males employed, is greater than the corresponding amount for females. This seems to be the case especially in textile areas. The districts in which the relative percentage of females in agriculture is 10—30 bigger than that of males are usually characterized by agriculture. The difference is bigger still if forestry and fisheries are to the fore.

Fig. 12 shows the percentage of persons employed in forestry and hunting. Although the percentage of this group for the whole country is only 1.3 (range 0—27.2), it is important, especially in sparsely populated districts. These are large, wooded areas, where forestry usually comes next to agriculture in importance. The map contrasts clearly with Fig. 9, which shows the percentage of agriculture. The connection between the relative percentage of those belonging to this group and the population density is even clearer.

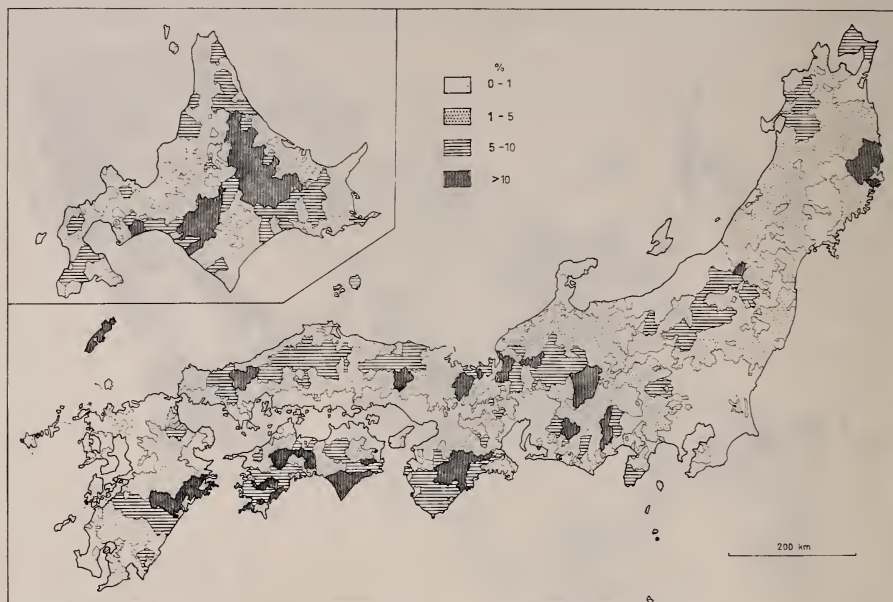


Fig. 12. Forestry and hunting as a percentage of all industries.

The percentage of forestry and hunting in primary industry is in one extreme case as big as 94.5, but this is quite exceptional (Higashi-ku in Osaka).

In the interior the percentage of persons employed in fisheries and aquiculture exceeds 0.1 only in exceptional cases. Because the relative number of this group is in question, the picture given by the map depends largely upon how much each district has of other population, e.g. non-coastal (Fig. 13). On the other hand, the small coastal population of many districts stretching far into the barren interior, e.g. in Hokkaido, exaggerates the importance of the fishing population. The same is true for the east coast of Tohoku (northern Honshu) and several other districts. As regards the coast, the map generally presents a contrast with the map showing the percentage for agriculture.

This industry group ranges from 0 to 79.3 % of the sum total of persons employed and from 0 to 98.3 % of that for primary industry.

Fig. 14 shows how the 1,317 districts fall into the triangle with regard only to primary industry (A) and its division into minor groups (1—3). There are units in 39 meshes of the triangle (39 %). The con-

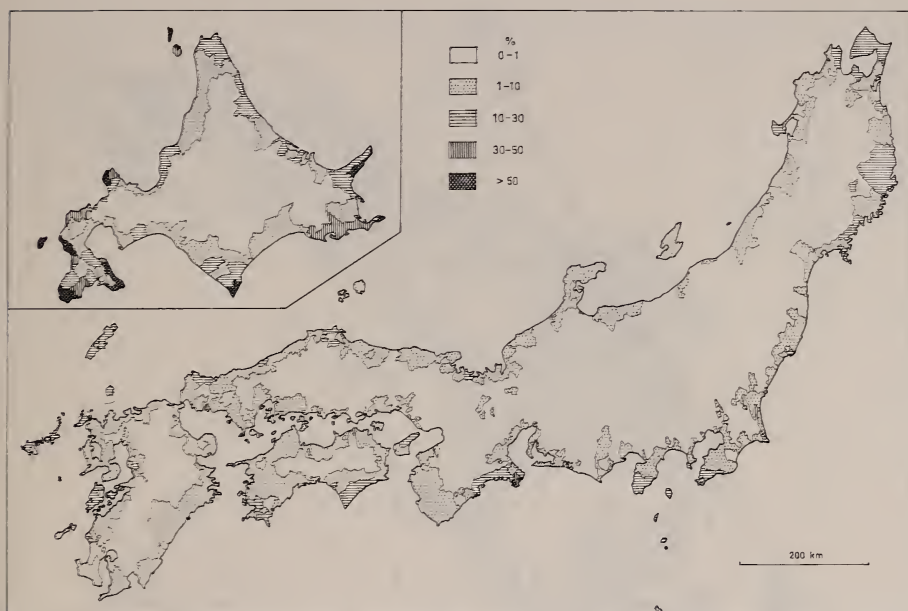


Fig. 13. Fisheries and aquiculture as a percentage of all industries.

centration towards agriculture is so strong that more than two-thirds of the units (68 %) are in the same mesh.

When primary industry and its division into minor groups in the whole of Japan are used as the basis for classification the districts are distributed among the various types as follows:

1	606	23	171
12	137	3	206
2	155	13	42

The districts in which agriculture's percentage of primary industry is bigger than the average for Japan (92.4) belong to group 1, the districts in which the percentage of persons employed in forestry is bigger than the average to group 2, etc.

In Fig. 15 the same major features can be seen as in Figs. 9, 12 and 13, but without the influence of the industries belonging to other major groups.

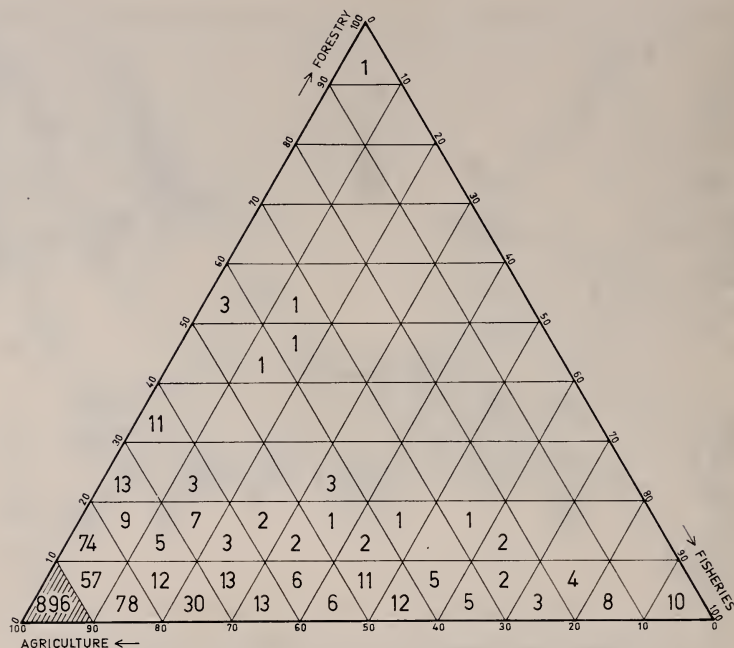


Fig. 14. Composition of primary industry by districts.

As regards primary industry, Japan appears to be divided into three major regions. In Hokkaido with few interruptions fishing characterizes the coasts. Most of the land area is characterized by forestry, which usually reaches the coast. Agriculture, in its turn, is mainly the industry of the flat inland areas, and only seldom does it come down to the coast.

The second major region is northern Honshu as far as the »Fossa Magna». Agriculture characterizes the greatest part of this region. Together with forestry, it is also widely characteristic. The major forestry areas are in the interior, but they reach the coast in many places. Fishing occasionally becomes more important, especially on the Pacific side. The connection between agriculture and flat areas is again clear. Although flat areas may occur only as narrow strips in the mountains, it can still determine the character of the whole district, as the majority of the inhabitants live in this very kind of terrain. On the map the land characterized by agriculture therefore seems to be out of proportion to the corresponding built-up area.

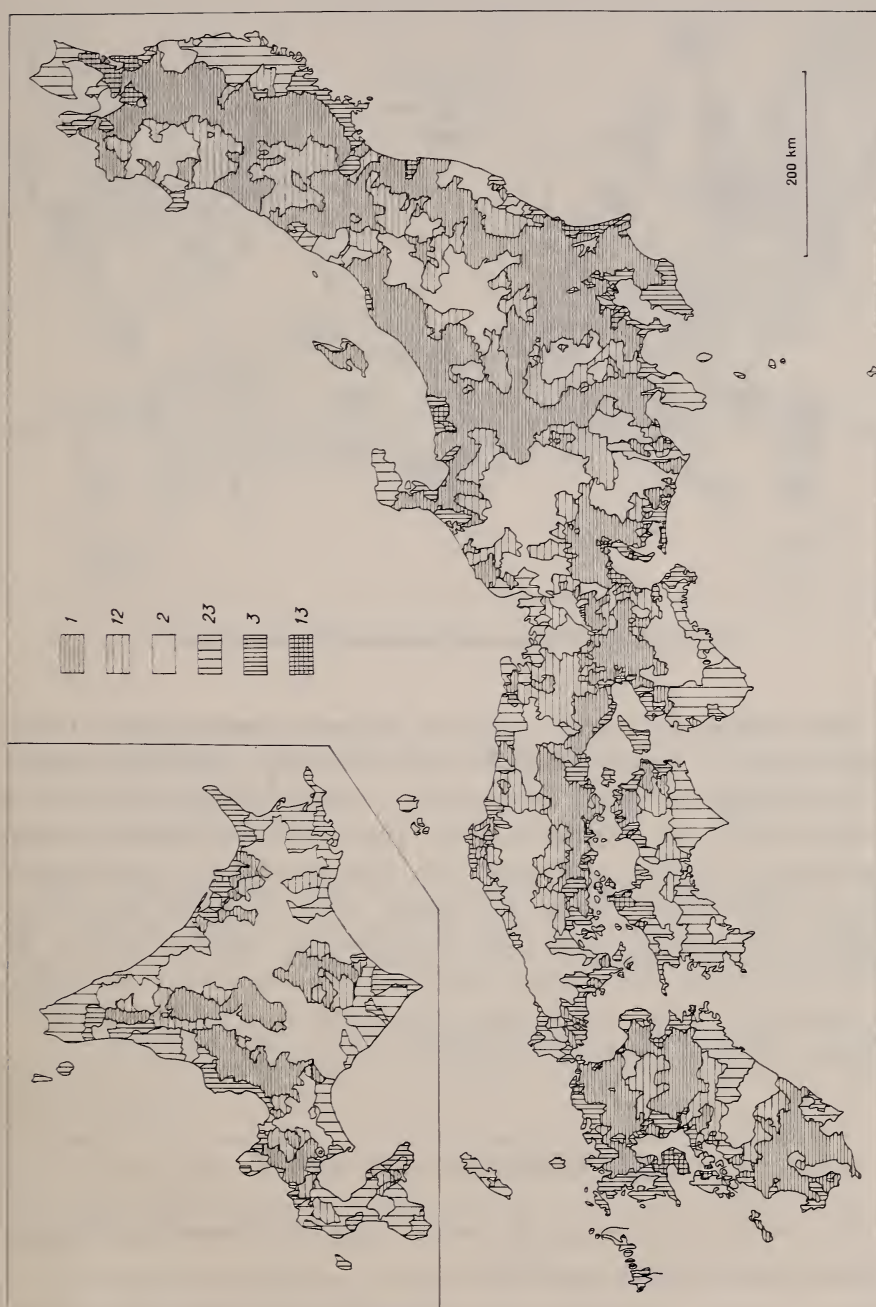


Fig. 15. Distribution of districts classified according to the composition of primary industry.

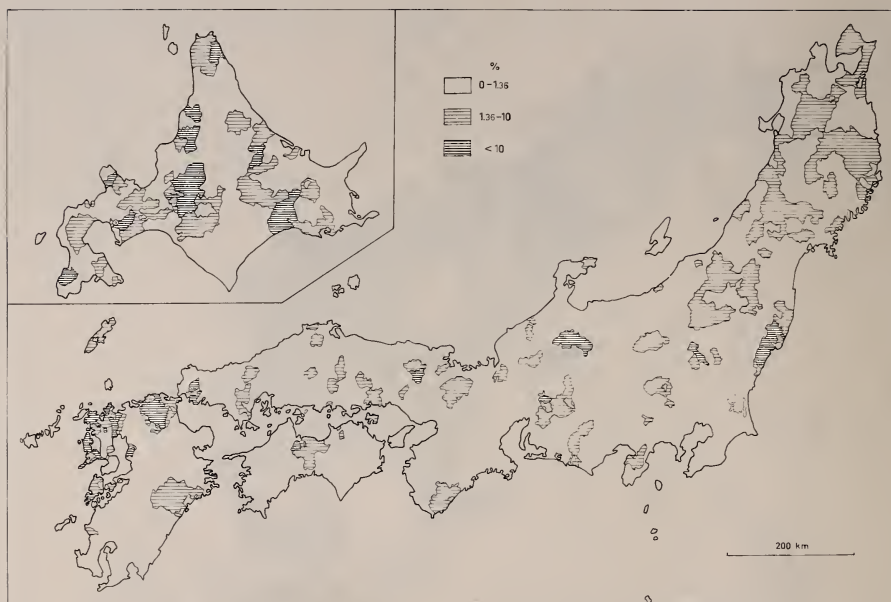


Fig. 16. Mining as a percentage of all industries.

The third major region comprises the south-west of Japan (western Honshu, the whole of Shikoku and of Kyushu). This area consists of longitudinal, somewhat discontinuous zones. In the center there is an agricultural zone, beginning in the Nagoya area and passing through the Inland Sea region to Kyushu. On both its sides there are forestry zones. Still further out are the fishing zones, of which that on the Pacific coast is quite continuous. Fisheries are important also in the Inland Sea region. The southern parts of Kyushu are again characterized by agriculture. This major region also shows how the distribution of primary industry has been influenced by physical features.

4. SECONDARY INDUSTRY

Expressed as a percentage the persons employed in secondary industry fall into minor groups as follows:

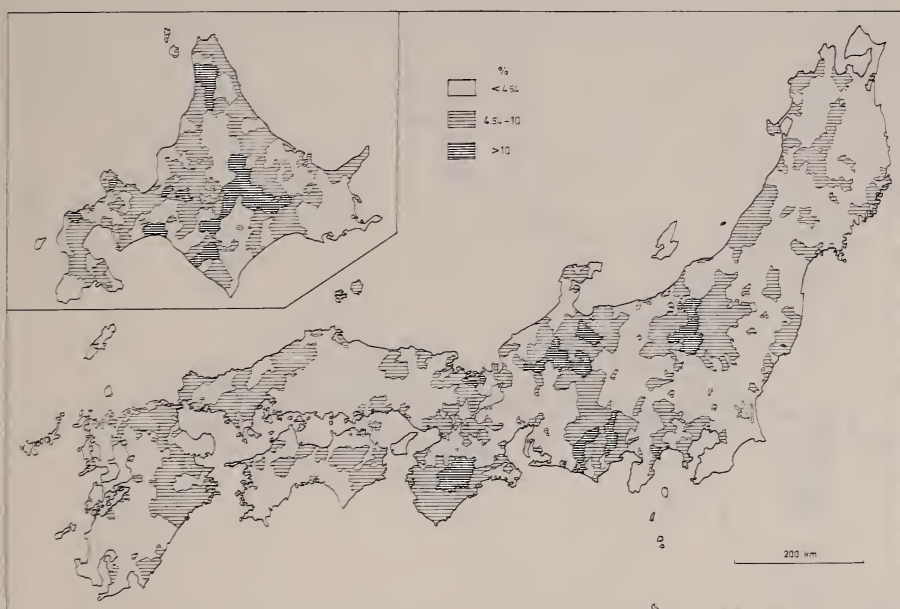


Fig. 17. Construction as a percentage of all industries.

(B) Secondary industry	23.5	100.0
(4) Mining	1.4	5.8
(5) Construction	4.5	19.3
(6) Manufacturing	17.6	74.9

Fig. 16 shows the districts in which mining's percentage of the sum total of persons employed exceeds the average. The districts where its percentage is more than 10 have been marked with a darker shading.

Mining's percentage of all industries ranges from 0 to 64.7. It has the highest value in Hokkaido in Utashinai-cho (Sorachi-shicho), where its percentage of secondary industry also is the biggest, or 90.3. In Hokkaido the distribution of this industry is clearly connected with that of coal-fields (Yubari, Ishikari, Kushiro, Rumoi and Tempoku). The map also shows some other mining areas, e.g. in the Abashiri district.

In Honshu the influence of the Yoban coal-field (Fukushima-ken) and the Kamioka area (Gifu-ken) and in Shikoku the area around



Fig. 18. Manufacturing as a percentage of all industries.

Niihama (Ehime-ken) deserve to be mentioned. The other major coal mining area of Japan besides that of Hokkaido is in northern Kyushu and south-western Honshu (western San-yo). The share of coal mining in all mining employment for Japan is two-thirds (66 %).

Fig. 17 shows the percentage of persons employed in construction in the same way as above. The percentage ranged between 0.7 and 32.7 and exceeded 20 only in a few districts. Its percentage of the secondary industry group ranged from 2.1 to 99.6.

Correspondence can be seen in the density of persons employed in agriculture, so that when the agricultural population is small compared with the area (population density generally small), and the forestry population is relatively large, the percentage of construction is often unusually great.

Fig. 18 shows the percentage of persons employed in manufacturing compared with the sum total of persons employed. The districts in which the percentage in manufacturing is greater than the average for Japan, have been shaded, and the more strongly shaded districts have a manufacturing percentage exceeding 30. Of the sum total of



Fig. 19. Relative majority of males or females in manufacturing. Cf. explanations in the text.

persons employed, 0.0—70.2 % belong to the manufacturing group, and of the persons employed in secondary industry manufacturing comprises 0.4—97.9 %. In both cases the greatest percentage is reached in Bisai-shi (Aichi-ken), whereas the percentage share of construction in secondary industry falls to its minimum.

The areas where manufacturing reaches its highest percentages are mostly in the zone that runs, somewhat discontinuously, from the neighbourhood of Tokyo to northern Kyushu. Manufacturing follows the coastline, extending however into the interior in the extensive flat Kanto, Nobi and central Kinki regions. The manufacturing districts are very clearly connected with densely populated areas.

Fig. 19 shows the result arrived at when it was investigated how large a percentage of on the one hand, the males employed and, on the other, of the females employed belong to the manufacturing group. The differences between the percentages were then marked on the map (the relative majority of males or females). Areas where females have a relative majority are connected especially with the textile

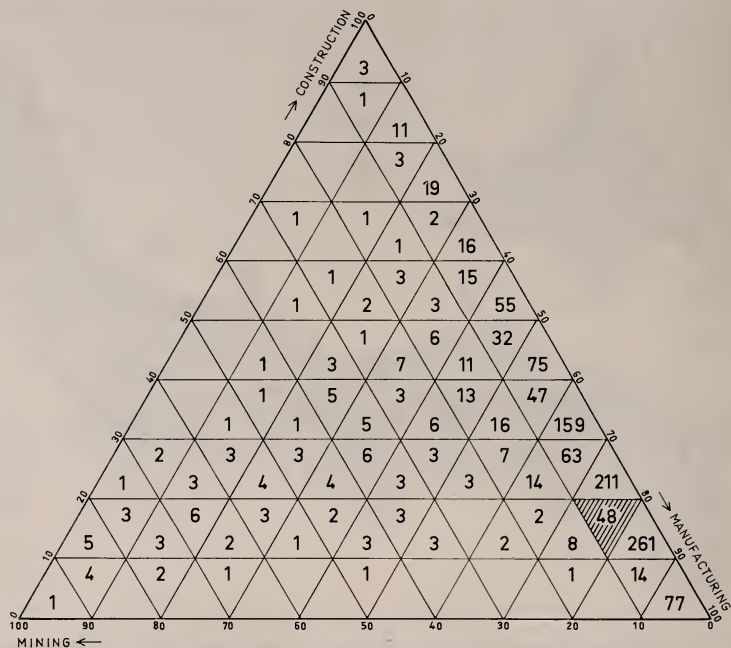


Fig. 20. Composition of secondary industry by districts.

industry, and areas with a majority of males with the metal and machine and chemical industries.

Considering only secondary industry and its division into minor groups, the districts fall into the triangle as Fig. 20 shows. There are units in 75 meshes (three-quarters of the total). Although they are dispersed over a large area, more than half of them are in four adjacent meshes.

Using the average composition of secondary industry for the whole of Japan as the basis for classification, the districts belong to the various minor types as follows:

4	54	56	123
45	238	6	363
5	530	46	9

The regional distribution of the units belonging to the various minor types is seen in Fig. 21. Districts characterized only by construction occur in unexpectedly large numbers, more than 40 %. This

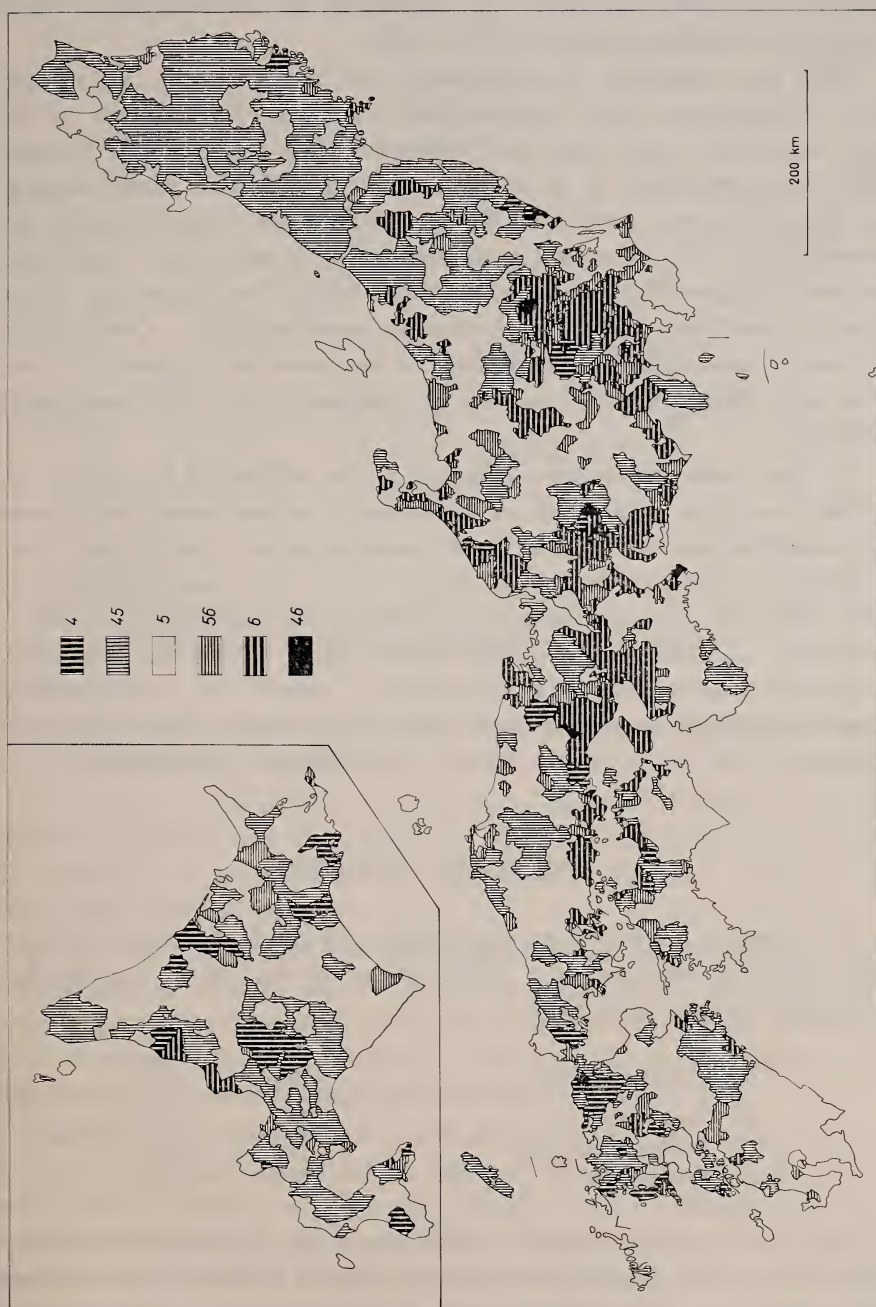


Fig. 21. Distribution of districts classified according to the composition of secondary industry.

district group must, however, be considered as the remainder, when the more specialized groups are set aside.

Also the frequency of combination 45 is astonishing, as mining alone characterizes only relatively few districts. This is due to the fact that stone, clay and sand extraction also rank under mining, and their percentage of it is bigger than e.g. that of metal mining. As mining proper (coal and metal mining) and manufacturing are concentrated in a somewhat restricted area, whereas sand extraction etc. and construction extend over larger areas, the occurrence of the latter in combination with each other is understandable. Combination 46 occurs least, which proves lack of dependence of groups 4 and 6 on each other. The occurrence of combination 56 seems somewhat occasional.

On the basis of secondary industry the whole of Japan can be divided into three major regions: 1. Hokkaido, where considerable areas are characterized by mining, and manufacturing districts are few. 2. Tohoku (northern Honshu), where the role of manufacturing is also small, but the combination of mining and construction is widely prevalent. 3. Central and south-western Japan, where manufacturing is largely characteristic and construction (outside the manufacturing areas) is far more important than in the former region. Kyushu, which belongs to this major region, bears a resemblance to Hokkaido.

5. TERTIARY INDUSTRY

Expressed as a percentage, the persons employed in tertiary industry (the group of services in a wider sense of the word) are divided into minor groups as follows:

(C) Tertiary industry	35.5	100.0
(7) Trade etc.	15.5	43.8
(8) Transportation etc.	5.2	14.7
(9) Services etc.	14.7	41.5

Fig. 22 shows the regional variations of the percentage taken by the minor group of wholesale and retail trade, finance, insurance and real estate (7). The districts where the percentage is bigger than

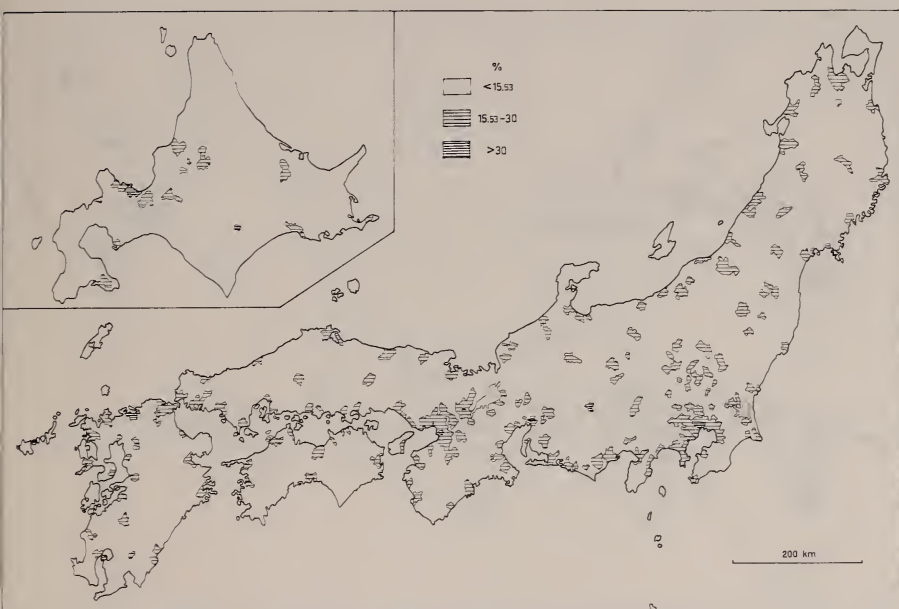


Fig. 22. Trade etc. as a percentage of all industries.

the average have been shaded, and the districts whose percentage exceeds 30 are more strongly shaded.

In the districts observed, trade ranges from 1.5 to 56.0 % of all persons employed, and from 4.5 to 75.8 % of tertiary industry (both the maxima are to be found in Higashi-ku in Osaka). Almost all the shaded districts are *shi*.

In the districts where the percentage of this minor group is big, the number of females in the group as compared to the sum total of females employed, is bigger than the corresponding figures for males. Thus it seems that where trade etc. is in need of more employees, females apply in greater numbers than males.

Besides transportation and communication, the next minor group (8) also comprises other public utilities (electric light and power, gas, water and sanitary services, together 1.6 % of tertiary industry). Fig. 23 shows the regional distribution of its percentage of all persons employed. The shaded districts again have a percentage bigger than the average for Japan, and the more strongly shaded have a percentage

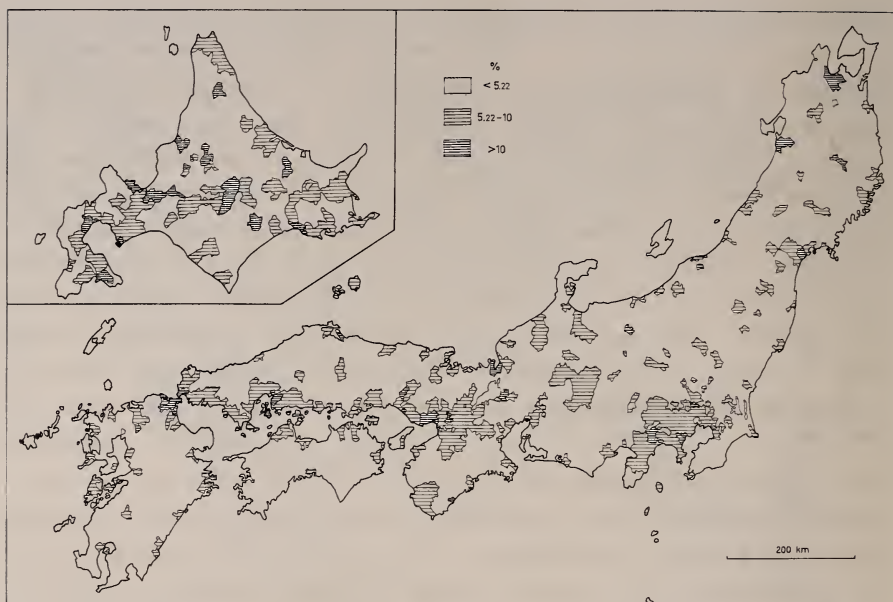


Fig. 23. Transportation etc. as a percentage of all industries.

exceeding 10. The percentages range from 0.6 to 35.2 and from 2.8 to 64.2 of tertiary industry.

This minor group compared with the sum total of persons employed is greater than the average only exceptionally in sparsely populated districts. Its distribution is generally in accordance with variations in population density. A few very sparsely populated areas in Hokkaido and the forestry and hydro-electric power areas e.g. in Nagano-ken and Gifu-ken, form exceptions to this. The concentration in group 8 is less marked than in the two other minor groups of tertiary industry.

The third minor group of tertiary industry is services in a more restricted sense (including the persons not classifiable, whose percentage of tertiary industry is, however, no more than 0.0). This minor group (9) ranges from 2.9 to 61.3 % of all persons employed and from 19.8 to 91.8 % of tertiary industry. The map (Fig. 24) resembles the figure showing the distribution of minor group 7 (trade etc.). For Hokkaido there are several districts other than *shi* belonging to the shaded areas, which is due to the fact that the district units



Fig. 24. Services etc. as a percentage of all industries.

for Hokkaido also comprise units smaller than *gun*. As in the minor group 7, an industry typical of urban districts is under consideration.

Considering only tertiary industry and its division into minor groups, the districts fall into the triangle indicated in Fig. 25. There are units in 40 % of the meshes, and much more than half of them (61.8 %) are in three adjacent meshes. Concentration is thus quite marked. Classifying the districts in the same way as above, they fall into minor types as follows:

7	223	89	346
78	125	9	273
8	239	79	111

As can be seen, trade etc. occurs least as a characteristic of districts. However, by itself it is relatively more frequent and thus more independent than the other minor groups included in tertiary industry, which occur in combinations with one another more often than by themselves.

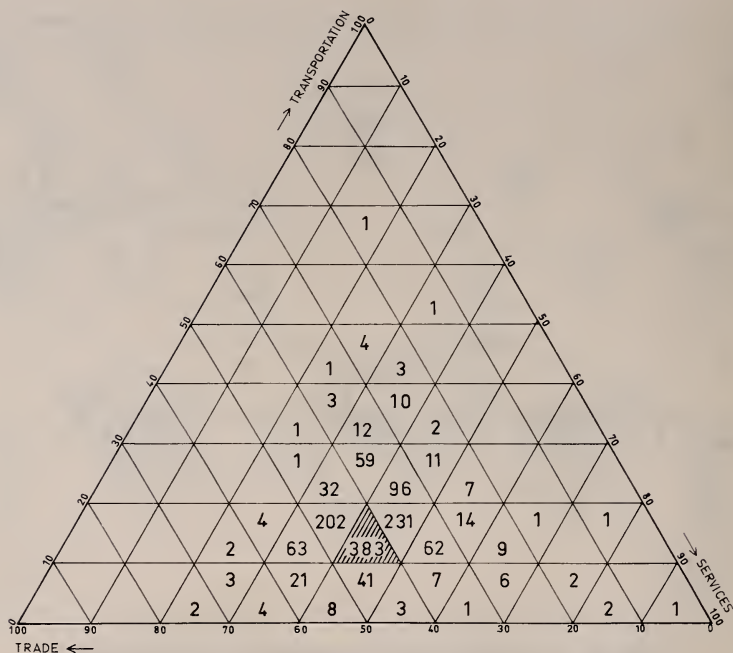


Fig. 25. Composition of tertiary industry by districts.

Half of the districts belonging to group 7 have a population density of between 100 and 600 per square kilometer. Only in Hokkaido are there districts whose density is smaller. On the other hand, more than half of the districts belonging to groups 8, 89 and 9 have a density of less than 200 (without Hokkaido less than 250). The average population density of the districts belonging to group 8 is somewhat smaller than that of those belonging to group 9. Thus industry groups 8 and 9 are mainly characteristic of sparsely populated areas and group 7 of more densely populated areas.

The dispersal of the percentages is generally small, so it is often chance which decides to which of the minor types a district belongs. The variegation of the map (Fig. 26) is also to some extent due to this. Using tertiary industry as the basis for classification, it is difficult to divide Japan into a few major regions.



Fig. 26. Distribution of districts classified according to the composition of tertiary industry.

6. SUB-TYPES OF INDUSTRIAL STRUCTURE

When the districts of Japan are divided into six types, with the three main components of industrial structure as the basis of classification, the result is the main types of industrial structure A , AB , B etc. mentioned above. When each main type whose symbol includes an A is subdivided further on the basis of minor groups 1, 2 and 3 the result is the sub-types A_1 , A_{12} , A_2 etc. Correspondingly, the sub-types, B_4 , B_{45} , B_5 etc. are arrived at.

Theoretically there are 126 sub-types, all possibilities of combination being taken into account. Of them are represented in this study 85, so that 10 of the most frequent sub-types cover 977 districts (74.2 %) and 20 of them 1,132 districts (86.0 %). As many as 35 of the sub-types are such as are represented by only 1 or 2 districts each.

The following table shows the types represented by at least 10 district units (84.6 % of the districts):

Type	<i>Gun</i> ¹	<i>Shi</i>	<i>Ku</i>	Total
A_1	254	89	—	343
A_2	99	5	—	104
A_{23}	84	17	—	101
A_{12}	89	9	—	98
A_3	75	17	—	92
B_6	16	57	—	73
B_6C_7	1	34	30	65
B_6C_{78}	1	19	18	38
A_7B_6	19	15	—	34
C_9	7	22	—	29
B_4	10	11	—	21
A_{13}	13	7	—	20
B_6C_8	4	13	3	20
B_6C_9	1	14	4	19
B_6C_{89}	1	11	6	18
C_{89}	4	13	—	17
C_8	3	9	—	12
C_7	1	7	2	10
Total	682	369	63	1,114

¹ *cho* and *mura* for Hokkaido.

Of the 203 remaining districts more than one-third belong to the main type BC . It may be mentioned that A_2 and C_7 never occur combined with each other.

The following table shows how many times the various signs occur alone or combined with each other in the symbols of all the districts:

Sign	Gun etc.	Shi	Ku	Total
A_1	394	141	—	535
A_2	314	42	—	356
A_3	194	65	—	259
B_4	40	31	—	71
B_5	30	50	15	95
B_6	59	204	75	338
C_7	6	104	63	173
C_8	21	116	36	173
C_9	22	106	20	148

In the rural districts (*gun*, for Hokkaido *cho* and *mura*) the absolutely most frequent signs are A_1 , A_2 and A_3 , in the order mentioned. The relatively greatest number of rural districts is to be found in the districts whose symbols include the sign A_2 and next come those including the signs A_3 and A_1 . The sign A_2 can thus be considered as denoting the most purely rural sub-type.

Signs B_4 and B_5 occur least frequently of all. As characteristics of rural or urban districts they are insignificant, although B_4 somewhat more often denotes rural, and B_5 urban, districts.

In the urban districts (*shi* and *ku*) the most frequent signs are in order B_6 , C_7 , C_8 and C_9 . Relatively most urban are those districts whose symbols include C_7 , after which follow C_8 , C_9 and B_6 . The sign C_7 can thus be considered as the most reliable proof of urbanisation.

The frequency with which a sign occurs in the symbols of all the districts, alone and in combination, shows approximately the independence of each industry as a characteristic of the types of industrial structure. When the relative number of times a sign stands alone in the symbol is counted, the order of the signs, starting with the most independent, is as follows:

A_1 ,
 A_3 , B_4 , A_2 , B_6 , C_9 ,
 C_8 , C_7 ,
 B_5

The most independent industry group characterizing industrial structure is agriculture. Of all the districts, 26.0 % are purely agricultural (A_1), and moreover there are combinations (mostly A_{12}) amount-

ing to 14.6 %. Agriculture is the only industry group which occurs by itself more frequently than in any of its combinations or in all its combinations together.

The second group in order of independence is formed by fishing etc. (3), mining (4), forestry (2), manufacturing (6) and services (9), all of which more often occur combined with one or two industry groups than alone. Of these, fishing and especially mining are remarkable independent in proportion to their frequency. This can be easily understood, as fishing depends on completely different factors than do the industries of the interior, and mining again depends on certain local factors (mineral deposits). Fishing is mostly combined with forestry, and mining with construction. Forestry and mining are somewhat more independent than would be expected from their frequency. This is due to the numerous combinations of the former with fishing and agriculture, and of the latter with trade and transportation. The group of services belongs to the same category as regards independence.

Transportation etc. (8) and trade etc. (7) are considerably less independent. Both of them are combined with one another as well as with manufacturing, the latter (7) much more often. It can be easily understood that transportation is not independent, as it is always attached to other industries. The most frequent of all the combinations are those characterized by both manufacturing and trade, which are thus quite closely attached each other.

By far the most dependent group is that of construction (5), which by itself characterizes only two districts. As regards only secondary industry, it was earlier shown that it characterizes quite a lot of districts, but was found have the nature of a residual group. Because in the main classification these districts belong to other main types, construction is not generally seen in the final classification.

Of all the persons employed in agriculture 57.4 % live in the 535 districts whose symbols include A_1 . The percentages corresponding to the different signs are as follows:

A_2	70.3	C_7	42.7
A_3	69.0	C_8	31.3
B_6	67.3	C_9	29.0
B_4	59.1	B_5	15.0
A_1	57.4		

Thus more than half of the persons employed in primary industry, manufacturing and mining live in the districts whose symbols include the signs corresponding to these industries. Less than half of the persons employed in the industries in question live in districts whose symbols include some of the tertiary industry signs or the construction sign. Altogether about half of the persons employed (49.8 %) live in districts whose symbols show the industry in question.

To give the home district of, for example, a farmer the sign A_1 , it is not enough that agriculture's share of primary industry is bigger than the average for Japan. Primary industry's share of all persons employed must also be bigger than the average. The more the industry in question is attached to other industries of the same major group (in this case primary industry), the better is this condition generally fulfilled. This explains the greatness of the above percentages of the primary industry minor groups and the smallness of those of the tertiary industry minor groups. The attachment of manufacturing to tertiary industry is strong, but on the other hand manufacturing is so centralized that the percentage is still great. The least independent minor group, construction, is the last in this list also.

As characteristic representatives of the most frequent urban types may be mentioned: Ichinomiya, as an example of a manufacturing city (B_6), Kiryu, representing the manufacturing and trade cities (B_6C_7), Amagasaki as an example of the manufacturing and trade-transportation cities (B_6C_{78}), and Yokosuka representing the service cities (C_9). The two biggest cities, Tokyo and Osaka, also belong to the manufacturing and trade cities, and Nagoya and Kobe are manufacturing and trade-transportation cities.

Other cities representative of the various types are, for example, the mining city (B_2) of Yubari, the manufacturing and transportation city (B_6C_8) of Akashi, the manufacturing and transportation-service city (B_6C_{89}) of Yokohama, the manufacturing and service city (B_6C_9) of Hachioji, the manufacturing and trade-service city (B_6C_{79}) of Kyoto, the trade city (C_7) of Kagoshima, the transportation city (C_8) of Nagano, the transportation-service city (C_{89}) of Chiba and the trade-service city (C_{79}) of Saga. All these examples have been chosen from among cities with more than 100,000 inhabitants.

It may also be pointed out that the *shi*, whose symbols do not include C and/or B , comprise an urban center, even if it is relatively

small. A system such as has been used in some studies — in which the rural industries are wholly left out of account when defining the type — is not in accordance with the principles of classification followed in this study.

7. REGIONAL DIFFERENTIATION OF INDUSTRIAL STRUCTURE

The industrial structure of the districts is seen from Appendices 1 and 2, which are complementary to each other. On the map (Appendix 2) the sub-types of the *A* type (A_1 , A_{12} etc.) are in black shading, the *B* and *C* types are shown respectively red and white. The combinations (e.g. A_1B , $A_{23}C$, BC etc.) appear on the map as combinations of the colours. As it has not been possible to represent the sub-types of the *B* and *C* types on the map, all the districts (and their symbols) belonging to the main types *AB*, *B*, *BC*, *C* and *AC* have been listed in Appendix 1. Thus, the districts of the *A* main type are missing from this list, but they can be found on the map.

The influence of the altitude and the degree of slope can be seen in the differentiation of the rural districts on the basis of industrial structure. Generally agriculture is the characteristic industry on level or gently sloping areas, but not on altitudes above its climatic limit, which varies according to geographical location. Where there are valleys in the interior, on the map they seem out of proportion regarding their area, as the greatest part of the population lives in these valleys, the rest of the districts in question being sparsely populated. Where there is cultivation on the hillside terraces it, too, is often on the borders of the gently sloping land. Forestry can be carried on from sea level to the climatically-determined forestline. Thus there are forestry regions almost everywhere where agriculture cannot be effectively carried on, with the exception of the areas situated at the highest level and on the steepest hillsides. Fishing is attached to the coast, with the exception of the comparatively insignificant freshwater fishing.

Where the land rises gently from the sea, the rural districts which reach the coast are almost without exception characterized by agriculture. Those agricultural areas extend as far as the degree of slope allows. If slope and altitude increase slowly, the type A_{12} appears

below the clearcut forestry regions. Due to depressions there, agricultural areas are also to be found in the interior. Where the land rises steeply from the sea the forestry region often extends right to the sea. On coasts like this the combination A_{23} is common, whereas the corresponding combination of the gently sloping coasts, A_{13} , is rare.

This correlation between the industrial structure and the absolute altitude and the degree of slope is quite clear in almost every part of Japan. The soil comparatively seldom causes any noticeable exceptions to the general rule. The considerable climatic differences between e.g. Hokkaido and Kyushu, and in Honshu between the region by the Japan Sea and the Pacific side, strongly influence the quality of agriculture (types of crops and number of harvests), but they do not affect the general picture of the regional differentiation of industrial structure.

As a characteristic of districts mining, either alone or in combination, is comparatively rare. The mining regions depend on mineral deposits, but without any general regularity. Real construction districts are non-existent, as construction, being the least independent of the industries, characterizes districts only when combined with various other industries.

The districts characterized by urban industries in the proper sense (manufacturing and tertiary industry) are situated, scattered or in groups of varying size and shape, mainly on the border of or surrounded by agricultural regions, and only seldom in forestry regions. By far the most densely populated part of those districts are on the coast. The largest of the continuous areas formed by urban districts are three metropolitan areas: Tokyo—Yokohama and its surroundings on the Kanto plain, Nagoya and its surroundings on the Nobi plain, and Osaka, Kyoto and Kobe with their surroundings on the lowland of Kinki. Present Kitakyushu and its surroundings could be added to these as the fourth area.

In the Nobi area the combinations B_6C_7 and B_6C_{78} prevail in the center, Nagoya. Around the main center is a mainly manufacturing area B_6 . In the Kanto plain metropolitan area, comprising two big centers, type B_6C_7 is characteristic of Tokyo (C_7 for the central ward of Chuo-ku), and type B_6C_{89} of Yokohama (C_{78} for the central ward of Naka-ku). Outside these major centers, too, the combinations of manufacturing and tertiary industry (especially B_6C_9) dominate, and still further away from the centers e.g. C_9 and B_6 . In the Kinki metropolitan

area, which comprises three big centers manufacturing occurs in Osaka mostly tied to trade (central ward of Minami-ku C_7), in Kyoto tied to trade or services and in Kobe to trade and transportation (central ward of Ikuta-ku C_{78}). The regions outside the major centers are characterized by manufacturing or its combinations with tertiary industry (especially those with trade and transportation). The occurrence of mining B_4 , both alone and combined with tertiary industry, is a specific feature of northern Kyushu, where many big *shi* have grown together. In the areas of Inland Sea, manufacturing B_6 is predominant, but various combinations also appear.

Thus concentric zonal differentiation is to be found especially in the three metropolitan areas. In the very center there is more or less marked commercial core, in the surrounding areas various forms of tertiary industry occur combined with manufacturing, and further still towards the peripheral areas manufacturing becomes more and more predominant. It is clear that each metropolitan area, and also each of its centers, has its own individual character, of which the type classification shows only the general outlines.

As for the appended map, it may be mentioned that the C main type can be seen more clearly in the districts where the share of the B type is small, because C is more regularly distributed throughout the country than B . For Hokkaido, the share of manufacturing in the B main type is smaller than for Japan Proper. The sign B_6 occurs in very few symbols.

To give a general picture of the regional differentiation of industrial structure Fig. 27 has been constructed by greatly simplifying the map, Appendix 2. The procedure has been as follows: The districts whose symbols include one of the combinations A_{12} , A_{23} or A_{13} have been divided into two to form as continuous areas of only one component (A_1 and A_2 , A_2 and A_3 etc.) as possible. Thus the transitional zones including the combination of the industries in question cannot be seen on the map. The fishing regions A_3 have been generalized as a zone including the combination of the industries in question cannot be seen of equal width along the coastline. To this have been added all districts (both *shi* and *gun* etc.) whose symbols include B and/or C (with or without an A) marked with circles. These circles have been placed in the center of population of each district. The part of the district not covered by the circles has been represented according to its primary industry structure.

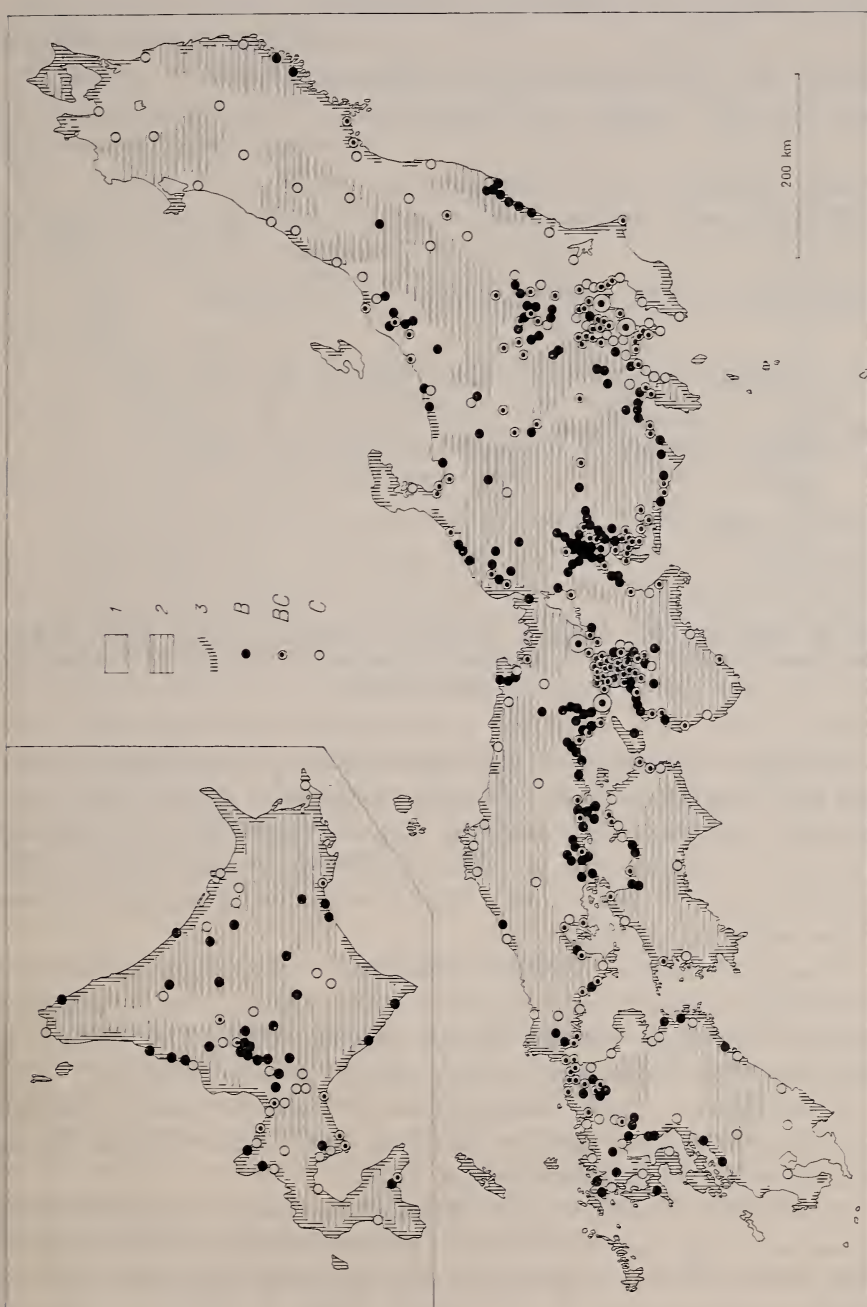


Fig. 27. Main features of regional industrial differentiation. Cf. explanations in the text.

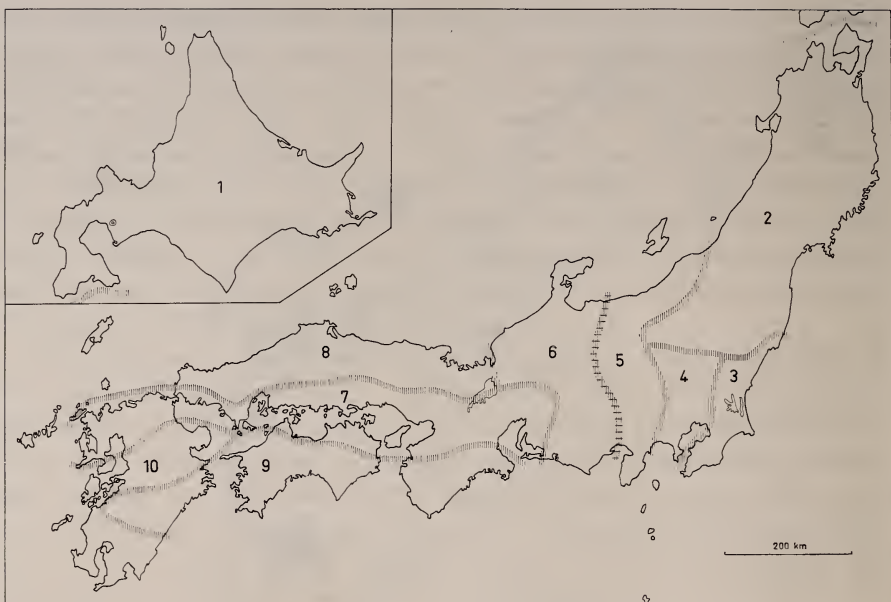


Fig. 28. Main industrial regions. 1. Hokkaido, 2. Tohoku, 3. Eastern Kanto, 4. Western Kanto, 5—6. Chubu, 7. Setouchi, 8. San-in, 9. Nankai, 10. Central and Southern Kyushu.

Although this picture of the differentiation of the industrial structure is a very general one, in certain respects it gives a better idea of some conditions than does the original map. This is especially true for the distribution of fisheries and partly also that of urban industries. At the same time it illustrates the major regional features of the industrial structure.

It is not possible to divide Japan into large regions which are industrially homogeneous. But some major regions can be delimited on the basis of the location of the various industries in relation to each other. The following is a very general division (Fig. 28):

1. *Hokkaido*. Coasts characterized by fisheries, most of interior by forestry and parts furthest inland by agriculture. Role of mining considerable, that of manufacturing small.

2. *Tohoku*. Lowlands and intermontane basins characterized by agriculture, highlands by forestry. Role of secondary industry small.

3. *Eastern Kanto*. Agriculture (and fisheries), mining on northern coast.

4. *Western Kanto*. Widespread manufacturing and tertiary industry. In addition, agriculture.

5 and 6. *Chubu*. Agriculture on north-eastern side and forestry on south-western side of line following Fossa Magna. Manufacturing characterizes urban districts.

7. *Setouchi* (Nobi plain and northern Kyushu included). Manufacturing and tertiary industry characteristic on the coasts, in northern Kyushu mining. In rural districts agriculture.

8. *San-in*. Forestry and, on coast, fisheries. Role of urban industries small.

9. *Nankai* (Kyushu Mountain District included). Forestry and fisheries. Role of urban industries small.

10. *Central and Southern Kyushu* (with exception of the part in preceding region). Agriculture prevalent.

In a very simple division of the districts based on industrial structure, the Fossa Magna line extending from Suruga Bay to the Itoigawa river (the border between north-eastern and south-western Chubu) is applicable as indicating the border of the two major parts of Japan Proper. To the north-east of it the agricultural districts surround the forestry districts which are mainly situated in the interior. The urban industries have concentrated in the Kanto area. To the south-west of the line, the urban industries occur mostly on the coast, in the agricultural zone and in its extensions along the Inland Sea. On both sides of this central zone forestry is predominant. The third major region of Japan is Hokkaido.

8. CONCLUSION

This study has been based upon the 1955 census of Japan. The areal units are the cities, the wards of the biggest cities and the rural counties (for Hokkaido their subdivisions), totalling 1,317 districts.

The percentages taken by primary, secondary and tertiary industry of all persons employed were 41.0, 23.5 and 35.5 respectively. The classification is based on comparison between the industrial structure for each district and that for the whole of Japan.

The most numerous main types are the A and BC ones, which together cover 75.1 % (57.6 % and 17.5 % respectively) of all the

units. The former, where only the percentage of primary industry exceeds the average, is the main type in rural areas. The latter, where the percentages of both secondary and tertiary industry exceed the average, is the main type in urban areas. Of the remaining districts 14.6 % represent the relatively one-sided, mainly urban *B* and *C* types and 10.4 % represent the combinations *AB* and *AC*.

The percentages of all persons employed in primary industry taken by agriculture, forestry etc. and fishing etc. were 92.4, 3.2 and 4.4 respectively. A comparison between the districts belonging to the main type *A* and the average structure for the whole of Japan resulted in the sub-types A_1 (agricultural or farming districts), A_2 (forestry districts), A_3 (fishing districts), A_{12} (farming-forestry districts) etc. The other main types have similarly been divided into sub-types.

The most numerous sub-type is A_1 . The most rural one, considered relatively, is however A_2 . As many as 95 % of the districts of this type are rural counties and their subdivisions. The most urban of the common sub-types is B_6C_7 (manufacturing and trade districts); of the districts here no less than 98 % are cities and wards.

Although the distribution pattern of the various types seems variegated, obvious regularity in the distribution of the types is still to be found. The distribution of the rural sub-types is decisively dependent upon physical conditions. The most obvious factors are the altitude, the degree of slope of the land, and the nearness of the coastline. Types characterized by urban industries in the proper sense are to be found in areas which, besides mostly meeting the conditions required for the effective operation of primary industry have other special qualifications. As far as type B_6 and its combinations are concerned, the supply of labor force and communications (especially by sea) are important, the influence of the other factors (such as the supply of raw material etc.) varying in the different branches of industry. Of the sub-types of tertiary industry, C_7 is most clearly concentrated in densely populated areas, C_9 being more evenly distributed. Concentric zonal structure is to be found in the distribution of the various sub-types in and near the great population agglomerations.

The changing nature of physical conditions determines the fact that Japan is also heterogeneous as regards the regional features of its industrial structure. There are no large areas that are industrially homogeneous. On the basis of the way the types of industrial structure

are distributed in different parts of the country in relation to each other, several major regions are discernible. Even in the most simplified regional division, Hokkaido stands out from the rest of Japan, which is divided into two parts virtually along the Fossa Magna. Further the Inland Sea area stands out clearly from its two bordering zones. A more detailed division into regions can be made in several ways.

In the regional distribution of primary industry no great changes are to be expected. In its present areas agriculture has almost reached its maximum extent, but can still be extended somewhat towards the sea and the slope lands. On the other hand, the areas of agriculture and forestry diminish as the urban population spreads.

The total number of persons employed in primary industry is decreasing, relatively as well as absolutely. At present it may be about 13 % smaller than in 1955 (calculated from the sum total of all persons employed). The other two major groups are constantly growing.

If fixed class limits in the type classification are used, as is usually the case in tracing the development of industrial structure ('static classification'), the decrease in the importance of primary industry mentioned above and the increase in that of the other industries appear in a large number of districts, no matter whether anything differing from the general development has occurred or not. If again such class limits as change with the average industrial structure are used, as has been done in this study ('dynamic classification'), this does not happen, because the changes that have taken place in the districts are seen only as they differ from general trend of development. At the same time the type classification maintains its ability to divide the material sufficiently.

Thus the static classification shows the nature of each unit and the way it develops independently of the whole to which it belongs. The dynamic classification shows the nature of the unit and the way it develops within the whole, part of which it comprises.

BIBLIOGRAPHY

- Aagesen, Aage, 1961: The Population. Atlas of Denmark II. København.
- Alexandersson, Gunnar, 1956: The Industrial Structure of American Cities. A Geographic Study of Urban Economy in the United States. Uppsala.
- » — 1958: Japan. En ekonomisk-geografisk översikt. Ymer.
- Beardsley, Richard K., Hall, John W. and Ward, Robert E., 1959: Village Japan. Chicago.
- Birukawa, S. and Yamato, S., 1964: Productivity of Agricultural Land and Intensity of Labour in Japan. Abstr. of Papers, 20th Internat. Geogr. Congr. London.
- Boustedt, Olaf and Ranz, Herbert, 1957: Regionale Struktur- und Wirtschaftsforschung. Aufgaben und Methoden. Raumforsch. u. Landesplan., Abhandl. 33. Bremen-Horn.
- Bureau of Statistics, Office of the Prime Minister, 1957/59: 1955 Population Census of Japan V. Report by Prefecture 1—46.
- » — 1958/59: Population Census of Japan 1955. Population Maps of Japan 1—3.
- » — 1959: 1955 Population Census of Japan III. Report for All Japan 1—2.
- » — 1960: Population of Japan. Summary of the Results of 1955 Population Census of Japan.
- » — 1961: 1960 Population Census of Japan. Final Count of Population October 1, 1960.
- Doi, Kikukazu, 1959: The Industrial Structure of Japanese Prefectures. Proceed. IGU Reg. Conf. Japan 1957. Tokyo.
- Duncan, Otis Dudley and Reiss, Jr., Albert J., 1956: Social Characteristics of Urban and Rural Communities, 1950. New York.
- Enequist, Gerd, 1955: Tätorternas yrkessammansättning. Svensk Geogr. Årsbok.
- » — 1957: Types of Agglomerations and Rural Districts. Atlas över Sverige 59—60. Stockholm.
- Eyre, John E., 1962: Mountain Land Use in Northern Japan. Geogr. Rev.
- Fehre, Horst, 1961: Die Gemeindetypen nach der Erwerbsstruktur der Wohnbevölkerung. Raumforsch. u. Raumordn.
- Fuchs, Roland J., 1964: Soviet Urban Geography. An Appraisal of Postwar Research. Annals Assoc. Amer. Geogr.
- Geographical Section, 1960: Population Density by Landform Division in Japan. Bull. Geogr. Survey Inst. VI.
- Grad, Andrew J., 1952: Land and Peasant in Japan. An Introductory Survey. Internat. Secretariat, Inst. Pacific Relations. New York.
- Harris, Chauncy D., 1943: A Functional Classification of Cities in the United States. Geogr. Rev.
- Hidaka, Tatsutaro, 1957: Population Density of Japan. Bull. Geogr. Survey Inst. V.
- IGU Regional Conference in Japan 1957, 1959: Regional Geography of Japan 1—7. Tokyo.
- Iizuka, Koji, 1959: Postwar Land Reform and Japanese Agriculture as seen from Standpoint of Human Geography. Proceed. IGU Reg. Conf. Japan 1957. Tokyo.
- Illeris, Sven, 1964: The Functions of Danish Towns. Geogr. Tidsskrift.

- Japanese Team for Comprehensive Development Plan of the Hanshin Metropolitan Region*, 1960: General Information on the Hanshin Metropolitan Region. Osaka.
- — — 1960: Basic Materials for Comprehensive Development Plan of the Hanshin Metropolitan Region I—II. Osaka.
- Kiuchi, Shinzo*, 1957: Centrifugal and Centripetal Urbanization in Japan. *Proceed. IGU Reg. Conf. Japan 1957*. Tokyo.
- — — 1964: A Brief Survey of Japanese Geography. Tokyo.
- Koda, Kiyoki*, 1959: Manufacturing Districts in Japan. *Proceed. IGU Reg. Conf. Japan 1957*. Tokyo.
- — — 1964: Structure of Industrial Areas in Japan. *Abstr. of Papers, 20th Internat. Geogr. Congr. London*.
- Lehmann, Heinz*, 1953: Zur Entwicklung der Gemeindetypisierung 1950—1952. *Forschungs- u. Sitzungsber. Akad. Raumforsch. u. Landesplan. III*.
- Lettrich, Edit*, 1964: Urbanization of Hungary in the Light of the Occupational Structure of her Population. *Applied Geogr. in Hungary. Stud. in Geogr. 2*. Budapest.
- Linde, Hans*, 1953: Grundfragen der Gemeindetypisierung. *Forschungs- u. Sitzungsber. Akad. Raumforsch. u. Landesplan. III*.
- MLádek, Jozef*, 1964: Rural Settlements in the Region of the East-Slovakian Iron-works. (*Vidiecke sídla v rájóné VSŽ.*) *Acta Geol. et Geogr. Univ. Comenianae, Geographica 4*.
- Motooka, Takeshi*, 1959: The Changes in Land Use in Japanese Agriculture after the War, especially in the Saga Plain and the Zenkoji Basin. *Proceed. IGU Reg. Conf. Japan 1957*, Tokyo.
- Nelson, Howard J.*, 1955: A Service Classification of American Cities. *Econ. Geogr.*
- Nice, Bruno*, 1960: Les types économiques des provinces italiennes d'après la structure de la population active. *Abstr. of Papers. XIX Internat. Congr. Stockholm*.
- Nishikawa, Osamu*, 1958: Japan. *Strukturwandel seiner Landwirtschaft. Geogr. Taschenbuch 1958/59*.
- — — 1958: Moderne Wandlung der japanischen Agrarlandschaft. *Verhandl. Deutsch. Geographentages 31*. Wiesbaden.
- Noh, Toshio*, 1960: Tohoku, the Northeastern Japan, as an Agricultural Region. *Abstr. of Papers, XIX Internat. Geogr. Congr. Stockholm*.
- Ogasawara, Yoshikatsu*, 1960: A Theoretical Approach to the Geographical Structure of Urban Functions and their Distribution Patterns. *Abstr. of Papers, XIX Internat. Geogr. Congr. Stockholm*.
- Population Problems Research Council, The Mainichi Newspapers*, 1956: Facts about Population of Japan shown in Figures and Charts. *Popul. Problems Ser. 14*.
- — — 1960: Facts about Japan's Population. *Popul. Problems Ser. 17*.
- Sandru, I. and Cucu, V.*, 1964: Classification of the Types of Towns in Rumania. *Revue Roumaine Géol., Géophys. et Géogr. Sér. Géogr. 8*.
- Scheidt, Leopold*, 1954: Die Agrarreform in Japan. *Peterm. Mitt.*
- Schöller, Peter*, 1962: Wachstum und Wandlung japanischer Stadtregionen. *Die Erde*.
- — — 1962: Wandlungen der Industriestruktur Japans. *Verhandl. Deutsch. Geographentages 33*. Wiesbaden.
- Schwind, Martin*, 1957: Betrachtungen zum japanischen Zensus von 1955. *Erdkunde*.

- Tachi, Minoru, Ueda, Masao and Hama, Hidehiko*, 1959: Regional Characteristics of Population in Japan. Proceed. IGU Reg. Conf. Japan 1957. Tokyo.
- Taeuber, Irene, B.*, 1958: The Population of Japan. Princeton, N. J.
- Tobata, Seiichi*, 1958: An Introduction to Agriculture of Japan. Tokyo.
- Trewartha, Glenn T.*, 1945: Japan. A Physical, Cultural, and Regional Geography. Madison, Wis.
- Tuominen, Oiva*, 1954: Zur Geographie der Erwerbe in Finnland. Eine Methode zur Gemeindeklassifikation nach der Erwerbsstruktur. Fennia 78, 3.
- — 1965: Suomen taajamat ja maaseutu elinkeinorakenteen valossa. (Die Erwerbsstruktur in Dichtorten und ländlichen Gegenden Finnlands.) Terra.
- Ueno, Fukuo*, 1959: The Problems of the Utilization of Slope Land in Japan. Proceed. IGU Reg. Conf. Japan 1957. Tokyo.
- Wallner, Ernő*, 1964: Japán gazdasági élete. Földrajzi Közlemények.
- Watanabe, Akira*, 1960: Regionality in Japan. Abstr. of Papers, Internat. Geogr. Congr. Stockholm.
- Yamaga, Seiji*, 1960: Urbanization in the Suburban Area of Large Cities. Chigaku Zasshi.
- Yamaguti, Sadao*, 1957: Die regionale Struktur der japanischen Industrie. Geogr. Rundschau.
- Yamamoto, Shozo and Masai, Yasuo*, 1965: Rural and Urban Land Uses of the Shimizu Area in Central Japan. A Geographic Study on the Modernization of a Region. Science Reports Tokyo Kyoiku Daigaku, Sect. C, 9.

APPENDIX 1

List of Districts

The 758 districts belonging to the main type A have been omitted (cf. Appendix 2). In each *ken* there are the *gun* (*cho* and *mura* for Hokkaido) separated from *shi* by lines.

Hokkaido	$A_{23}C_{89}$
Sapporo	B_3C_{89}
Asahikawa	B_3C_8
Otaru	$B_{36}C_{78}$
Hakodate	$B_{36}C_8$
Muroran	$B_{36}C_8$
Kushiro	$B_{45}C_8$
Obihiro	C_{78}
Kitami	C_{78}
Yubari	B_4
Iwamisawa	C_8
Abashiri	A_3C_{89}
Rumoe	C_8
Tomakomai	B_3C_{89}
Wakkanai	C_{89}
Bibai	B_4
Ashibetsu	B_4
Ebetsu	B_5
Akabira	B_4
Mombetsu	B_4
Teine	A_1C_{89}
Toyohira	C_9
Eniwa	C_9
Chitose	C_9
Kurisawa	A_1B_4
Mikasa	B_4
Sunagawa	B_{36}
Kamisunagawa	B_4
Naie	$A_{12}B_4$
Takikawa	C_{89}
Utashinai	B_4
Fukagawa	C_{78}
Numata	A_1B_{45}
Kamikawa	A_2B_5
Kamifurano	A_1C_9
Yamabe	$A_{12}B_4$
Nayoro	C_{89}
Shimokawa	A_2B_{45}

Yoichi	A_3C_7
Furubira	$A_{23}B_{45}$
Tomari	B_4
Iwanai	C_7
Kutchan	$A_{12}C_{89}$
Esashi	$A_{23}C_{89}$
Kamiiso	$A_{23}B_5$
Oshamambe	C_8
Date	A_3C_8
Sobetsu	A_2B_{45}
Abuta	C_9
Horobetsu	$B_{45}C_{89}$
Oiwake	C_8
Shizunai	$A_{23}B_5$
Samani	$A_{23}B_5$
Kawanishi	$A_{12}C_9$
Shintoku	A_2B_5
Kamishihoro	A_2B_5
Akan	B_{45}
Shiranuka	$A_{23}B_4$
Ombetsu	B_{45}
Nemuro	B_6C_8
Bihoro	$A_{12}C_9$
Rubeshibe	A_2B_{45}
Engaru	A_2C_{89}
Maruseppu	A_2B_4
Sarufutsu	$A_{23}B_{45}$
Obira	A_2B_{45}
Onishika	$A_{23}B_6$
Haboro	$A_{23}B_4$

Aomori-ken	A_3
Aomori	C_8
Hirosaki	A_1C_7
Hachinohe	C_7
Iwate-ken	A_{12}
Morioka	C_{89}

Kamaishi	B_4	Kanuma	A_1B_6
Miyako	$A_{23}C_8$	Nikko	B_5C_{89}
Ofunato	$A_{23}B_5$	Oyama	C_8
Miyagi-ken	A_3	Kamitsuga	$A_{12}B_{45}$
Sendai	C_{89}	Aso	$A_{12}B_{46}$
Ishinomaki	$B_{56}C_7$	Ashikaga	B_6
Shiogama	B_5C_{78}	Gumma-ken	A_1
Akita-ken	A_{12}	Maebashi	$B_{56}C_{79}$
Akita	C_{89}	Takasaki	B_6C_{78}
Yokote	A_1C_{78}	Kiryu	B_6C_7
Odate	$A_{12}C_8$	Isesaki	B_6
Yamagata-ken	A_1	Ota	B_6C_9
Yamagata	C_{79}	Shibukawa	B_5C_{78}
Yonezawa	B_6	Yamada	A_1B_6
Tsuruoka	C_{79}	Saitama-ken	A_1B_6
Sakata	A_1C_{78}	Kawagoe	C_{89}
Shinjo	A_1C_8	Kumagaya	C_7
Fukushima-ken	A_1	Kawaguchi	B_6C_7
Fukushima	C_9	Urawa	B_6C_{79}
Aizuwakamatsu	C_7	Omiya	B_6C_8
Koriyama	$B_{56}C_{89}$	Gyoda	B_6
Taira	C_{78}	Chichibu	B_6
Shirakawa	C_{78}	Tokorosawa	C_9
Haramachi	A_1C_8	Hanno	B_6C_9
Joban	B_4	Honjo	B_6
Iwaki	A_3B_5	Hanyu	A_1B_6
Uchigo	B_{45}	Kitaadachi	B_6
Nakoso	B_{45}	Chichibu	A_2B_4
Ibaraki-ken	A_1	Chiba-ken	A_{13}
Mito	C_9	Chiba	C_{89}
Hitachi	B_{46}	Chashi	B_6C_7
Tsuchiura	C_9	Ichikawa	B_6C_7
Koga	B_6C_{78}	Funabashi	B_6C_9
Takahagi	B_{45}	Tateyama	A_3C_{89}
Taga	$A_{23}B_4$	Kisarazu	A_3C_9
Tochigi-ken	A_1	Matsudo	C_{89}
Utsunomiya	C_{79}	Noda	B_6C_{78}
Ashikaga	B_6C_7	Narashino	B_6C_8
Tochigi	B_6C_7	Kashiwa	A_1C_8
Sano	B_6	Tokyo-to	B_6C_7
		Tokyo	B_6C_7
		Chiyoda	B_6C_7

Chuo	C_7
Minato	B_6C_7
Shinjuku	$B_{56}C_{79}$
Bunkyo	B_6C_{79}
Taito	B_6C_7
Sumida	B_6C_7
Koto	B_6C_{78}
Shinagawa	B_6C_7
Meguro	B_6C_{79}
Ota	B_6C_7
Setagaya	$B_{56}C_9$
Shibuya	$B_{56}C_{79}$
Nakano	$B_{56}C_{79}$
Suginami	B_6C_{79}
Toshima	$B_{56}C_7$
Kita	B_6C_7
Arakawa	B_6C_7
Itabashi	B_6C_9
Nerima	B_6C_9
Adachi	B_6C_{78}
Katsushika	B_6C_7
Edogawa	B_6C_7
Hachioji	B_6C_9
Tachikawa	C_9
Musashino	B_6C_9
Mitaka	B_6C_9
Ome	B_6C_9
Fuchu	$B_{56}C_9$
Akishima	B_3C_9
Chofu	B_6C_{89}
Nishitama	$B_{45}C_9$
Minamitama	C_{89}
Kitatama	B_6C_9
Kanagawa-ken	$B_{56}C_{89}$
Yokohama	B_6C_{89}
Tsurumi	B_6C_8
Kanagawa	$B_{56}C_8$
Nishi	$B_{56}C_8$
Naka	C_{78}
Minami	$B_{56}C_{89}$
Hodogaya	B_6C_{89}
Isogo	B_6C_{89}
Kanazawa	$B_{56}C_9$
Kohoku	B_6C_{89}
Totsuka	B_6C_{89}
Yokosuka	C_9

Kawasaki	B_6C_8
Hiratsuka	B_6C_{79}
Kamakura	$B_{56}C_9$
Fujisawa	B_6C_{89}
Odawara	B_6C_8
Chigasaki	B_6C_{89}
Zushi	$B_{56}C_9$
Sagamihara	C_9
Miura	A_3C_7
Hatano	C_{89}
Miura	B_3C_9
Koza	C_9
Ashigarakami	$A_{12}B_{56}$
Ashigarashimo	C_9
Aiko	$A_{12}B_6$
Niigata-ken	A_1
Niigata	$B_{56}C_8$
Nagaoka	B_6C_{78}
Takada	C_9
Sanjo	B_6C_7
Kashiwazaki	$B_{45}C_9$
Shibata	A_1C_9
Niitsu	A_1C_8
Kamo	B_6
Tokamachi	A_1B_6
Mituke	B_6
Murakami	C_8
Tsubame	B_6
Naoetsu	B_{56}
Tochio	A_1B_6
Gosen	A_1B_6
Nishikubiki	A_3B_{56}
Toyama-ken	A_1
Toyama	$B_{56}C_7$
Takaoka	B_6C_{78}
Shimminato	$B_{56}C_7$
Uozu	A_3B_6
Ishikawa-ken	$A_{13}B_6$
Kanazawa	B_6C_7
Nanao	A_3C_{89}
Komatsu	B_6
Enuma	B_6
Nomi	A_2B_4

Fukui-ken	A_2B_{56}	Numazu	B_6C_{78}
Fukui	B_6C_7	Shimizu	B_6C_{78}
Tsuruga	B_5	Atami	C_9
Takefu	B_6C_7	Mishima	B_6C_{78}
Katsuyama	$A_{12}B_6$	Fujinomiya	B_6
Sabae	B_6	Ito	C_9
Yoshida	$A_{12}B_6$	Shimada	B_6
Ono	A_2B_{45}	Yoshiwara	B_6
Imadate	A_2B_6	Iwata	B_6C_7
		Yaizu	A_3B_6
Yamanashi-ken	A_1	Fuji	B_6
Kofu	$B_{56}C_7$	Gotemba	C_9
Fujiyoshida	B_6	Sunto	B_6
Tsuru	B_6	Ihara	A_1B_{56}
Otsuki	B_6	Iwata	A_2B_{45}
		Hamana	A_3B_6
Nagano-ken	A_{12}	Aichi-ken	B_6C_{78}
Nagano	C_8	Nagoya	B_6C_{78}
Matsumoto	B_6C_{79}	Chikusa	$B_{56}C_7$
Ueda	B_6C_7	Higashi	B_6C_7
Okaya	B_6	Kita	B_6C_7
Iida	$B_{56}C_7$	Nishi	B_6C_7
Suwa	B_6C_9	Nakamura	B_6C_{78}
Suzaka	B_6	Naka	B_6C_7
Omachi	$A_{12}B_{56}$	Showa	B_6C_7
		Mizuho	B_6C_7
Gifu-ken	$A_{12}B_6$	Atsuta	B_6C_{78}
Gifu	B_6C_7	Nakagawa	B_6C_{78}
Ogaki	B_6	Minato	$B_{56}C_8$
Takayama	C_{89}	Minami	B_6C_{78}
Tajimi	B_6C_7	Toyohashi	B_6C_7
Seki	A_1B_6	Okazaki	B_6C_7
Nakatsugawa	B_6	Ichinomiya	B_6
Mino	B_6	Seto	B_6
Mizunami	B_{46}	Handa	B_6C_{78}
Hashima	A_1B_6	Kasugai	$B_{56}C_{89}$
Toki	B_6	Toyokawa	C_9
Inaba	A_1B_6	Tsushima	B_6
Hashima	B_6	Hekinan	B_6
Fuwa	A_1B_6	Kariya	B_6
Toki	B_6	Koromo	B_6
Yoshiki	A_2B_{45}	Anjo	A_1B_6
		Nishio	A_1B_6
Shizuoka-ken	B_{56}	Gamagori	B_6
Shizuoka	B_6C_7	Inuyama	B_6
Hamamatsu	B_6C_7	Tokoname	B_6

Moriyama	B_6C_8
Konan	B_6
Bisai	B_6
Aichi	A_1B_6
Higashikasugai	B_{46}
Nishikasugai	B_6
Niwa	A_1B_6
Haguri	B_6
Nakashima	A_1B_6
Ama	A_1B_6
Chita	B_6
Hekikai	A_1B_6
Hazu	A_3B_3
Hoi	A_3B_6
Mie-ken	A_{23}
Tsu	B_6C_9
Yokkaichi	B_6
Ise	B_6C_8
Matsusaka	A_3C_7
Kuwana	B_6C_7
Suzuka	$A_{13}B_6$
Owase	C_7
Mie	A_1B_6
Shiga-ken	A_{12}
Otsu	B_6C_{89}
Hikone	B_6C_{89}
Nagahama	B_6
Kurita	A_1B_6
Kyoto-fu	B_6C_{79}
Kyoto	B_6C_{79}
Kita	B_6C_9
Kamigyo	B_6C_7
Sakyo	B_6C_9
Nakagyo	B_6C_7
Higashiyama	B_6C_{79}
Shimogyo	B_6C_7
Minami	B_6C_{78}
Ukyo	B_6C_{89}
Fushimi	B_6C_{89}
Fukuchiyama	A_1C_{89}
Maizuru	B_3C_9
Uji	B_6C_{89}

Miyazu	$A_{23}C_{89}$
Otokuni	B_6C_{89}
Yosa	$A_{23}B_6$
Naka	A_1B_6
Takeno	$A_{23}B_6$
Osaka-fu	B_6C_7
Osaka	B_6C_7
Kita	B_6C_7
Miyakojima	B_6C_{78}
Fukushima	B_6C_7
Konohana	$B_{36}C_8$
Higashi	B_6C_7
Nishi	$B_{36}C_7$
Minato	B_3C_8
Taisho	B_6C_{78}
Tennoji	B_6C_7
Minami	C_7
Naniwa	B_6C_7
Oyodo	B_6C_{78}
Nishiyodogawa	B_6C_{78}
Higashiyodogawa	B_6C_{78}
Higashinari	B_6C_7
Ikuno	B_6C_7
Asahi	B_6C_{78}
Joto	B_6C_{78}
Abeno	B_6C_7
Sumiyoshi	B_6C_7
Higashisumiyoshi	B_6C_7
Nishinari	B_6C_7
Sakai	B_6C_7
Kishiwada	B_6C_7
Toyonaka	B_6C_7
Fuse	B_6C_7
Ikeda	B_6C_7
Suita	B_6C_{78}
Izumiotstu	B_6
Takatsuki	B_6C_8
Kaizuka	B_6
Moriguchi	B_6C_{78}
Hirakata	B_6C_{89}
Ibaraki	B_6C_8
Yao	B_6C_{78}
Izumisano	B_6
Tondabayashi	B_6C_9
Neyagawa	B_6C_{89}
Kawachinagano	B_6C_{89}

Hiraoka	B_6C_7	Nara-ken	$A_{12}C_{89}$
Kawachi	B_6C_{78}	Nara	C_9
Matsubara	B_6C_{78}	Yamatotakada	B_6C_7
Mishima	B_6C_8	Yamatokoriyama	B_6C_{89}
Hono	C_8	Tenri	A_1C_9
Semboku	B_6	Ikoma	A_1B_6
Sennan	B_3	Shiki	A_1B_6
Minamigawachi	B_6C_8	Takaichi	B_6C_7
Nakagawachi	B_6C_{78}	Kitakatsuragi	B_6
Kitagawachi	B_6C_8	Minamikatsuragi	B_6
		Uchi	A_1C_{78}
Hyogo-ken	B_6C_{78}	Yoshino	A_2B_5
Kobe	B_6C_{78}		
Higashinada	B_6C_{78}	Wakayama-ken	$A_{23}B_5$
Nada	B_6C_{78}	Wakayama	B_6C_7
Fukiai	B_5C_{78}	Kainan	B_6C_7
Ikuta	C_{78}	Gobo	B_5C_7
Hyogo	B_6C_{78}	Tanabe	C_8
Nagata	B_6C_{78}	Shingu	B_5C_{78}
Suma	B_6C_8		
Tarumi	B_6C_8	Kaiso	$A_{23}B_5$
Himeji	B_6C_{78}	Ito	A_2B_5
Amagasaki	B_6C_{78}		
Akashi	B_6C_8	Tottori-ken	A_2
Nishinomiya	B_6C_{78}	Tottori	C_9
Sumoto	B_6C_{78}	Yonago	C_{89}
Ashiya	B_6C_7		
Itami	B_6C_9	Shimane-ken	A_{23}
Aioi	B_6	Matsue	C_9
Toyooka	A_3C_{78}	Hamada	A_3C_8
Kakogawa	B_6	Izumo	A_1C_9
Tatsumo	A_1B_6	Gotsu	$A_{12}B_{56}$
Ako	B_6		
Nishiwaki	B_6	Okayama-ken	A_1
Takarazuka	$B_{56}C_9$	Okayama	$B_{56}C_7$
Miki	A_1B_6	Kurashiki	B_6C_9
Takasago	B_6C_8	Tsuyama	A_1C_7
Kawanishi	B_6C_{78}	Tamano	B_6
Ono	A_1B_6	Kojima	B_6
		Tamashima	B_6
Kato	A_1B_6	Ibara	A_1B_6
Taka	$A_{12}B_6$		
Kasai	A_1B_6	Wake	A_3B_4
Innami	B_6	Kojima	B_6
Ibo	A_1B_6	Tsukubo	A_1B_6
Asako	$A_{12}B_4$		
		Hiroshima-ken	C_{89}
		Hiroshima	$B_{56}C_{78}$

Kure	$B_{56}C_9$
Mihara	B_6
Onomichi	C_7
Innoshima	B_6
Matsunaga	B_6
Fukuyama	B_6C_7
Fuchu	B_6
Miyoshi	A_1C_{78}
Otake	B_6
Aki	C_{89}
Numakuma	A_3B_6
Fukayasu	A_1B_6
Ashina	A_1B_6

Yamaguchi-ken	A_{23}
Shimonoseki	$B_{56}C_8$
Ube	B_4C_{78}
Yamaguchi	C_9
Hagi	A_3C_7
Tokuyama	B_5C_8
Hofu	C_{89}
Kudamatsu	B_6
Iwakuni	B_5C_{89}
Onoda	B_4C_8
Hikari	B_5C_{89}
Yanai	A_1C_{78}
Mine	A_2B_4
Asa	A_1B_4

Tokushima-ken	A_2
Tokushima	B_6C_7
Naruto	B_6C_{89}
Komatsushima	C_{89}

Kagawa-ken	A_{13}
Takamatsu	C_7
Marugame	B_6C_7
Sakaide	B_6C_8
Zentsuji	C_9
Kanonji	$A_{13}C_7$

Ehime-ken	A_{23}
Matsuyama	C_{79}
Imabari	B_6C_7
Uwajima	C_{78}
Yawatahama	B_6C_7
Niihama	B_6C_8

Saijo	B_6
Iyomishima	B_4
Kawanoe	B_6
Nii	B_4

Kochi-ken	A_{23}
Kochi	C_{79}

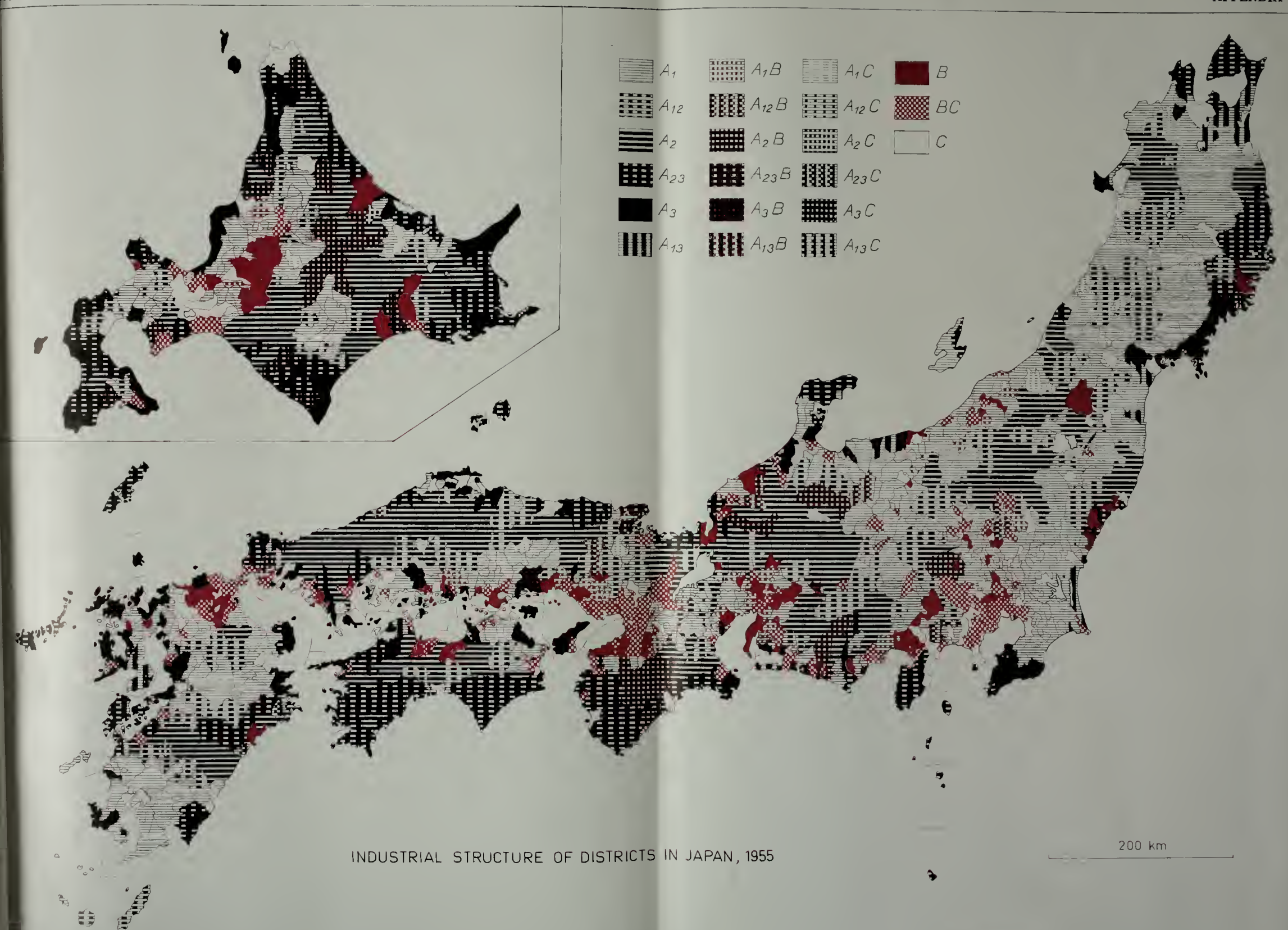
Fukuoka-ken	B_4C_{89}
Fukuoka	C_{79}
Wakamatsu	B_4C_8
Yahata	$B_{46}C_8$
Tobata	B_6C_8
Naogata	B_4C_8
Iizuka	B_4C_7
Kurume	B_6C_9
Omuta	B_4C_9
Kokura	$B_{45}C_8$
Moji	$B_{45}C_8$
Takawa	B_4C_9
Yamada	B_4
Yame	A_1B_6
Chikugo	A_1B_6
Okawa	B_6
Yukuhashi	$A_{13}C_{89}$

Kasuya	B_4
Onga	B_4C_9
Kurate	B_4
Kaho	B_4
Chikushi	C_9
Tagawa	B_4

Saga-ken	A_1
Saga	C_{79}
Karatsu	C_8
Tosu	C_8
Taku	B_4
Nishimatsuura	B_6

Nagasaki-ken	A_3
Nagasaki	B_6C_{79}
Sasebo	C_9
Shimabara	A_3C_9
Omura	A_3C_9
Matsuura	A_3B_{45}
Kitamatsuura	A_3B_4

Kumamoto-ken	A_{23}	Tsukumi	A_3B_{45}
Kumamoto	C_9	Kitaamabe	A_3B_5
Yatsushiro	$B_{56}C_9$		
Hitoyoshi	A_2C_9	Miyazaki-ken	A_2
Arao	B_1	Miyazaki	C_{79}
Minamata	B_6C_9	Miyakonojo	C_{79}
		Nobeoka	B_6
		Hyuga	$A_{23}C_8$
Oita-ken	A_{23}	Kagoshima-ken	A_1
Oita	C_{89}	Kagoshima	C_7
Beppu	C_9	Naze	C_9
Nakatsu	C_9		
Saiki	$A_{23}C_{89}$		



ÜBER DIE MENGE UND DEN KREISLAUF DER
SEDIMENTE, BETRACHTET VOM GESICHTSPUNKT
DER MODERNEN GEOMORPHOLOGIE

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ÜBER DIE MENGE UND DEN KREISLAUF DER SEDIMENTE, BETRACHTET VOM GESICHTSPUNKT DER MODERNEN GEOMORPHOLOGIE

In der Ausbildung der eruptiven, sedimentären und metamorphen Gesteinsgruppen, in der damit zusammenhängenden Wanderung der Elemente ebenso, wie im ganzen Stoffverkehr der geographischen Hülle können wir zwei Kreisprozesse unterscheiden. Der erste von denselben stellt einen endogenen und gleichzeitig exogenen Prozess dar, in dem die Gesteine, die zu verschiedenen Gesteinsgruppen gehören, sich ineinander umwandeln, wie folgt: Magmatit → Verwitterung und Abtragung → Sediment → regionale und kontaktete Metamorphose → metamorphe Gesteine → Migmatitbildung → Anatexis → Magma → Magmatit (Szádeczky, 1955).

Innerhalb des vorigen läuft der kleine Kreisprozess folgendermaßen ab: Gestein → Verwitterung, Abtragung → Sedimentation → Sedimentgestein.

Die einzelnen Erscheinungen der Sedimentbildung und des Sedimentverkehrs der geographischen Hülle können unseres Erachtens von den oben genannten Kreisprozessen nicht getrennt werden. Die älteren Forschungen bezüglich der Menge und des Kreislaufs der Sedimente hatten diesen Umstand nicht ausreichend berücksichtigt. Clarke (1924) bzw. Goldschmidt (1926) geben z.B. für die ganze Erde eine Sedimentmenge von 350—370 Million km^3 an.

Nach Kuenen (1941, 1950) beträgt die Gesamtmenge der Sedimente — im Gegensatz zu Clarke und Goldschmidt — doppelt so viel, also rund 700 Million km^3 . (Unsere eigenen Rechnungen zur Berichtigung von Clarke's Angaben hatten zu demselben Ergebnis geführt.) Kuenen hat nämlich auch die für 3 km mächtig geschätzte Sedimente berücksichtigt, die den Grund der tiefen ozeanischen Becken bedecken. Die alten ozeanischen Becken mit einer Ausdehnung von rund 200

Million km² dürfen wohl eine wirklich grosse, etwa 600 Million km³ betragende Sedimentausfüllung aufweisen. Die Auswertung der Mächtigkeit der Sedimente scheint uns auch stichhaltig, soweit es mit 1 Meter mächtiger Ablagerung roter Tiefseetone für je eine Million Jahre gerechnet wird.

Das Wesentliche unseres Beitrags zum Problem der Menge und der Kreislaufs der Sedimente lässt sich in der Feststellung zusammenfassen, dass wir diese Prozesse uns weit mehr verwickelt vorstellen müssen, als die erwähnten Autoren angenommen hatten. Wenn wir einen guten Überblick über den Kreislauf des Stoffes während der Abtragung und Sedimentbildung gewinnen wollen, müssen wir — im Gegensatz zu den früheren Autoren — von den Stoffmengen ausgehen, die durch das fliessende Wasser und die Wirkung von anderen äusseren Kräften in das Meer gefördert werden.

Es handelt sich um die folgenden Menge:

Geschiebe, das im Wasser schwebend transportiert wird	
/Bruns, 1958/	8,0 Milliard t
Gelöstes Material	9,7 „ „
Glaziale Geschiebe /Láng/	~ 1,0 „ „
Staub und Sand, verfrachtet vom Wind	unbedeutend
Abrasions — bzw. Brandungsgeröll /Láng/	~ 1,0 Milliard t
insgesamt	19,7 Milliard t

Es handelt sich also hauptsächlich um das geschwemmte und gelöste Material. Wenn wir bei den Flüssen durchschnittlich mit einer Konzentration der Lösung von 200 gr/m³ rechnen, und das geschwemmte Material mit 300 gr pro Kubikmeter in Betracht ziehen, ergibt sich von der jährlichen Wasserführung der Flüsse (38000 km³) insgesamt 19 Milliard t Geschiebemenge, die jährlich ins Meer geraten muss. Das ist etwa einem Umfang von 7 km³ gleich, darf aber nur für die geologische Gegenwart und jüngste Vergangenheit als gültiger Durchschnittswert betrachtet werden. Diese Periode ist auf der Erde durch die grosse Ausdehnung der Festländer, und die grosse Anzahl der Hochgebirge, die ja die grösste Abtragung aufweisen, gekennzeichnet. Weit längere Epochen der Erdgeschichte waren aber durch stark verschiedene, sogar mit den vorigen entgegengesetzte Umstände charakterisiert. So werden wir wohl das Richtige treffen, wenn wir annehmen, die äusseren Kräfte hätten während der letzten 3,5 Milliard Jahre der

Erdgeschichte durchschnittlich $1 \frac{1}{3} \text{ km}^3/\text{Jahr}$ Schutt vom Festland ins Meer geliefert. Das ist eine riesige Menge, mehr als fünfmal so viel, wie es von Kuenen gerechnet wurde, und die fünfzehnmal die Werte von Clarke und Goldschmidt überschreitet.

Wir dürfen aber nicht ausser acht lassen, dass in der ersten, azoischen Periode der Erdgeschichte die Verwitterung wegen Mangel des organischen Lebens viel langsamer vor sich ging; der von manchen Verfassern vermutete geringere Sauerstoffgehalt der damaligen Atmosphäre dürfte diese Prozesse ebenfalls verlangsamen. Dadurch sehen wir berechtigt, für die letzte, durch Denudation der Festländer charakterisierte 2,5 Milliarden Jahre des Archaikums bloss den realistischen Wert von $> 1 \text{ km}^3/\text{Jahr}$ für die Sedimentbildung anzunehmen. Wenn wir von der Theorie L. Egyed's (1956) über die Expansion der Erde ausgehen, steht diese Annahme auch mit der damaligen kleineren Ausdehnung der Erdoberfläche im Einklang.

Aber selbst so müssen wir zu ungeheuren Mengen geraten: im Archaikum und Algonkium soll etwa 3400 Millionen km^3 , seit dem Anfang des Kambriums wieder 1300 Millionen km^3 Sediment entstanden sein. Diese Sedimenthülle könnte die ganze Erdoberfläche — die Ozeane mit einbegriffen — in 9,5 km Mächtigkeit bedecken. So viel Sediment gibt es auf der Erde selbstverständlich nicht.

Nach unserer Auffassung sind aber die sich fortlaufend ablagernde (Regenerations-) Sedimente in den Stille'schen Revolutionsabschnitten der Erdgeschichte in den Faltungszonen der Geosynklinalen vielerorts metamorphisiert geworden, und diese metamorphen Gesteine hatten sich nach vielen Jahrmillionen wiederum zu Sedimenten verwandelt. Dieser Prozess hatte sich in den sich stets neubildenden Geosynklinalen mehrere Male wiederholt. So können wir uns leicht vorstellen, dass grosse Mengen der Sedimente mehrere Male ihren Zustand zwischen den Formen von metamorphem und sedimentärem Gestein wechselten. Mit den wiederholten Orogenesen hatten sich selbstverständlich die dadurch entstandenen plutonischen und vulkanischen Gesteine ebenfalls in den metamorph-sedimentären Zyklus eingeschaltet. Das war natürlich auch mit der Wanderung des primären Na-Gehalts der Sedimente verbunden; wenn man das nicht berücksichtigt, kann man leicht zu unrichtigen Folgerungen kommen.

So z.B. im Archaikum können wir drei grosse Revolutionsabschnitte unterscheiden. Jeder von denselben muss Gebiete von wenigstens 30

Tabelle 1.

Umriss des Stoffverkehrs der festen Erdkruste

Grosse Abschnitte der Entwicklung der Oberfläche	Ungefähre Ausdehnung des Fest- landes (10 ⁶ km ²)	Ungefähre Ausdehnung des Gebirge (10 ⁶ km ²)	Dauer der Ruhe- bzw. Abtragungs- periode (10 ⁶ Jahre)	Durchschnitt- liche Ab- tragung vom Festland (km ³ /Jahr)	Gesamte abge- tragene Menge (10 ⁶ km ³)
Prelaurentium	80	—	1500	0,67	100
<i>Laurentische-svekofennide</i>					
<i>Orogenese</i>		30			
Postlaurentische Ruheperiode	80		900	1,0	100
<i>Algomische-karelische</i>					
<i>Orogenese</i>		30			
Postalgomische Ruheperiode	90		350	2,0	70
<i>Assyntische Orogenese</i>		30			
Prekaledonische Ruheperiode	110		300	2,5	70
<i>Kaledonische Orogenese</i>		25			
Postkaledonische Ruheperiode	115		200	3,0	60
<i>Variszische Orogenese</i>		25			
Postvariszische Periode	130		180	3,5	60
<i>Alpidische-pazifische</i>					
<i>Orogenese</i>		25			
Alpidische Abtragung bis zur Gegenwart	150		20	5,0	10
Insgesamt			3450		470

—35 Million km² beeinflusst, und grosse Stoffmengen in Bewegung gesetzt haben:

a) Die laurentische (protoafrizida, svekofennida, indaya) Faltung vor etwa 1800—2000 Million Jahren.

b) Die algomische (karelida, angarische, minas) — Faltung vor ungefähr 1000—1200 Million Jahren und

c) Die kanadische, assyntische und südafrikanische Faltung vor 700—800 Million Jahren im Algonkium.

Ähnliche Rolle müssen wir auch den späteren kaledonischen, varistischen und alpiden-pazifischen Orogenesen zuschreiben.

Grund der Formung der Oberfläche

der uralten Rümpfe (10 ⁶ km ³)	Abtragungsprodukte der Magna- gesteine (10 ⁶ km ³)	Abtragungsprodukte der jungen Gebirge (10 ⁶ km ³)	Durchschnittliche Mäch- tigkeit der abgetragenen Schichten auf dem Gebiet der uralten Rümpfe, bis zur Gegenwart, (km)	Durchschnittliche Mäch- tigkeit der abgetragenen Schichten in den Gebirgen bis zur Gegenwart, (km)	Tiefesedimente von der gesamten Abtragungsmenge A (10 ⁶ km ³)	Durch Orogenesen aufgefaltete Sedimentmenge (10 ⁶ km ³)
00	—	—	29,0	—	300	
	—	—		20		700
50	40	600	17,0		200	
				15		700
80	20	450	12,5		70	
				12		500
90	20	350	10,0		60	
				10		300
90	10	250	7,0		40	
				8		300
90	10	200	4,0		40	
				4		400
—	~2	100	~1,0		10	
00	~102	1950			720	2900

Aus der Tabelle 1. ergibt sich also als

Gesamtmenge der Sedimente im Archaikum:	3400 Million km ³
„ „ „ Neogaeikum:	1300 „ „
Davon:	
Insgesamt	4700 Million km ³
In die Gebirge aufgefaltete Sedimentmengen im Archaikum	1900 Million km ³
In die Gebirge aufgefaltete Sedimentmengen im Neogaeikum	1000 „ „
Insgesamt	2900 Million km ³

Da die Sedimente während der orogenetischen Perioden grössten-
teils auch mehrmals ihre Erscheinungsform gewechselt haben (meta-
morphie bzw. sedimentäre Gesteine), müssen wir von der 4700 Million

km³ wenigstens 2500 Million km³ für die Gesteinmengen abschreiben, die wiederholt am Kreislauf teilgenommen haben. So können wir seit der ersten Abtragungsperiode im unteren Archaikum mit effektiver Bildung von 2200 Million km³ Sediment rechnen. Dieser Betrag enthält die Gesteinmengen, die von den primären Flächen der Urkontinente fortlaufend abgetragen wurden, so wie auch die Abtragungsprodukte der Magmatite, die erst später an die Oberfläche aufgestiegen sind. So setzen wir — nach Verhoogen — z.B. die Gesamtmenge der im Neogaeikum entstandenen Ergussgesteine auf etwa 40 Million km³, deren mehr als die Hälfte schätzungsweise schon abgetragen worden ist. Das Volumen der ganzen Erdkruste beträgt (Szádeczky, 1955) 15000 Million km³.

Für die gebietsmässige Verteilung der nachweisbaren gegenwärtigen und ehemaligen Sedimente (2200 Million km³) nehmen wir die folgenden Verhältnisse als massgebend an:

Rote Tiefseetone in Tiefen über 4000 m	~ 700 * Million m ³
Hemipelagische und Flachseesedimente	~ 300 * " "
Ehemalige Sedimente der alpinisch-pazifisch-mezozoisch gefalteten, metamorphen Zonen	~ 300 " "
Ehemalige Sedimente im Paleozoikum gefalteter, tiefliegender metamorpher Zonen	~ 200 " "
Ehemalige Sedimente der archaisch-algonkisch gefalteten, tiefliegender metamorpher Zonen	~ 100 " "
Durch Anatexis und Palingenesis in die Erdkruste einverleibte und metamorphisierte Sedimentmassen	~ 400 " "
Terrestrische Sedimente	~ 200 * " "

Die gegenwärtige Gesamtmenge der Sedimente (* siehe auch die Tabelle) übertrifft Kuenen's Angaben mehr als um das anderthalbfache, doch die Ergebnisse der in stets grösserer Zahl vorhandenen Tiefbohrungen scheinen die von uns angenommene Menge von 1200 Mill. km³ zu bestätigen. (Die Schätzungen von Clarke und Washington über die Sedimente der äusseren Erdkruste bis zur Tiefe von 16 km geben 320 Million km³ Tonschiefer und Ton, sowie 80 Million km³ Kalk- und Sandstein an.)

Von den obigen Zahlen über den Sediment- und Stoffverkehr der Erde können vielseitige Folgerungen gezogen werden. Es sind in erster Reihe die riesigen Posten dieses Verkehrs auffallend, die auf den sehr verwickelten Vorgang der Formung der Oberfläche hinweisen. Wohl den merkwürdigsten Zug stellt die enorm grosse Abtragung des primären Materials der Erdkruste, der Granite aus dem ältesten

Abschnitt des Archaikums dar. Von den uralten Rümpfen der primären Sial-Krustenblöcke von etwa 70—80 Million km² Gebiet — muss eine mehr als 25 km mächtige Schichtenfolge abgetragen worden sein. Dies bedeutet den überwiegenden Teil der in den Kreislauf eingetretenen Sedimente; die Verwitterung der Vulkanite und Plutonite, die seit der laurentischen Orogenese bis zur Gegenwart an die Oberfläche geraten sind, tragen mit kaum mehr als einem Zehntel dazu bei. Die Abtragung des Materials in einer Mächtigkeit von 25 km setzt die ständige, ausgleichende isostatische Hebung der Urkratonen voraus. Das ist nicht unbedingt mit der fortwährenden Dünnung der Erdkruste an den Gebieten der kontinentalen Blöcke verbunden, sondern wir können uns durch die Zuströmung und Festigung des Magmas die Regeneration der Sialischen Krustenteile sehr gut vorstellen. Ausserdem besonders in den grossen Revolutionsperioden der Entwicklung können die Zieh- bzw. Spannkkräfte selbst im Inneren der Urkontinente Brüche hervorrufen, und in Zusammenhang damit können neue Intrusionen, neuer Vulkanismus entstehen; die jungtertiären Riolutausbrüche von Lappajärvi (Mittel-Finnland) und ähnliche Ereignisse auch anderswo in Skandinavien bieten guten Beispiel dafür.

Einen wichtigen Moment der Regeneration der Kruste stellt weiterhin die Anatexis und Palingenesis der Geosynklinal-Sedimente dar, die durch die orogenetischen Bewegungen in grosse Tiefe geraten und mit den in ihre Nähe gedruckenen Magmagesteinen in Wechselwirkung getreten sind. (Solche durch Schmelzung erfrischte und umgewandelte Eruptive können später z.T. Auch bis zur Oberfläche aufsteigen). Die von uns geschätzte 400 Million km³ metamorphisierte und eingeschmolzene Sedimentmenge ist auf mehrere Million km² Gebiet ein anhaltender Bestandteil der festen Erdkruste geworden, denn es sind mehrere hundert Million Jahre notwendig, diese Gesteine von einer Tiefe bis 15—20 km wieder auf die Oberfläche zu bringen. Oberhalb der Zone der Anatexis und Palingenesis liegt die metamorphe Wurzel- und Mittelzone der sechs grossen Orogenesen, die der Abtragung noch nicht zum Opfer gefallen ist; je jünger der Orogen, desto mächtiger ist diese Zone. Die metamorphe Gesteinsmenge von etwa 600 Million km³ stellt vorläufig einen Teil der kontinentalen Blöcke der Erdkruste dar, tritt aber mit ergänzendem Charakter bloss auf deren Randgebieten (ungefähr 70—80 Million km²) in den Vordergrund. Wenn wir auch die Orogene des Meeres in Betracht ziehen, gelangt dieser Typ zu grösserer Ausdehnung. Die metamorphen Massen können sich

während mehrere hundert Million Jahre wieder zu Sedimenten umwandeln, die aber durch die inzwischen eintretenden Orogenesen wieder metamorphisiert, zum Teil sogar eingeschmolzen werden können. Es gibt hier also viele reversible Vorgänge.

Unter den geschilderten Prozessen des Sedimentverkehrs sind die mit Sedimentbildung verbundene Abtragung des Festlandes sowie die Aushebung desselben durch orogenetische oder epirogenetische Bewegungen von fortdauerndem Charakter. Die Metamorphose der Gesteine und die Anatexis, die Palingenesis treten zeitweise, in Zusammenhang mit den heftigen Orogenesen auf, ebenso, wie die Verstärkung der beiden Formen des Magmatismus. Der Kreislauf der Sedimente, die sich bald in das harte Gesteinsmaterial der Erdkruste einbauen, bald wieder zu lockeren Sedimenten zurückwandeln, wird periodisch, in Zusammenhang mit den wiederholten Revolutionen der Kruste beschleunigt.

Als Resultat der Wechselwirkung der endogenetischen Prozesse und der von denselben stark beeinflussten Abtragung lässt sich eine langsame Zunahme und Anhäufung der lockeren Sedimente an der Oberfläche der Festländer, und noch viel mehr am Meeresgrund feststellen. Nach unseren Angaben beträgt die Menge der roten Tiefseetone 700 Mill. km³, die der lockeren Sedimente der seichteren Meere 300 Mill. km³, während die lockeren terrestrischen Sedimente können wir auf etwa 200 km³ schätzen. Die Anhäufung der genannten Sedimente geht nur in die eine Richtung vor sich, stellt also einen irreversiblen Prozess dar, besonders in den tiefen Becken der Urozeanen.

Die fortwährende, langsame Anhäufung des Materials am Meeresgrund führt uns zum Problem, wie sich die Entwicklung eigentlich abspielen mag. B. Bulla hat schon im Jahre 1954 über eine rhythmische Entwicklung der Oberfläche geschrieben, die also kein zyklischer Kreisprozess ist, sondern ein Vorgang, deren jede einzelne Stufe etwas qualitativ neues gegenüber dem vorigen Stand bedeutet. In gleichem Sinn erklärte Szádeczky (1955) den grossen und kleinen geochemischen Kreislauf in dieser Formulierung für täuschend, da es einen »unveränderten, jeder Entwicklung entbehrenden ewigen reversiblen Kreislauf« andeutet, obgleich diese Prozesse in der Wirklichkeit auch mit irreversiblen Veränderungen verbunden sind. Es handelt sich also im anorganischen Leben der Erde gar nicht um eine immerwährende Wiederholung, sondern um eine tatsächliche Ent-

wicklung, um keinen echten Kreislauf, vielmehr um eine spiralförmige Bewegung mit einem eindeutig gerichteten Komponent. Diese bestimmte Richtung macht sich in der progressiven Entwicklung des Schalenaufbaus der Erde, ebenso, wie in den stets zunehmenden Unterschieden des Ionisationsgrades erkennbar. In der Entfaltung dieser Unterschiede, in der Konzentration und Verteilung der Elemente müssen wir — nach Szádeczky — auch der Ausbildung des organischen Lebens eine grosse Rolle zuschreiben, die selbst mit den anorganischen Prozessen in Wechselwirkung steht. Die Verbreitung des organischen Lebens hatte eine starke Zunahme des Sauerstoffgehalts der geographischen Hülle zu Folge. Die so entstandenen Gesteine von starkem Oxydationsgrad sind durch die genannten starken tektonischen Bewegungen wieder in die Tiefe der Erdkruste gelangen und abermals zu Gesteinen von geringerem Ionisationsgrad zurückgewandelt worden. Das immer stärker differenzierte Material, die von der Oberfläche in die Tiefe kommt, tritt dort mit dem Magma in Wechselwirkung, und so dürfen wir eine gewisse Wirkung aufs Innere der Erde von der Oberfläche her keinesfalls für ausgeschlossen halten.

Die grossen Mengen der Sedimente, welche sich auf dem Grund der ozeanischen Becken, die in den Krustenbewegungen bis jetzt gar nicht teilgenommen haben, ansammeln, sind Beweise und auch Gradmesser einer gewissen Irreversibilität der behandelten Prozesse. Es sind dort ansehnliche Massen der verschiedenen Elemente, z.B. Fe, Mn, Al, Ca angehäuft, als Produkte des Entwicklungsvorganges, welcher ganz besonders durch die langsame Abnützung und gleichzeitiger Regeneration der Kruste gekennzeichnet ist, da durch die Migmatitbildung und Anatexis immer grössere, vom inneren der Erde empordringende Magmamassen daran geknüpft sind. Bedeutende Teile dieser magmatischen Massen — vorerst nur der Vulkanite, später auch der Plutonite — werden durch die Abtragung in Form der irreversiblen »eingefrorenen« Sedimente der Festländer und hauptsächlich der Tiefseebecken aufgeschichtet. Das hat weniger die Zunahme des Erdkernes zu Folge, vielmehr wächst dadurch die Silikatkruste auf Kosten des Nickeleisenkernes an (also umgekehrt, wie es von Szádeczky behauptet wird). Dieser Vorgang scheint hauptsächlich mit der Expansionstheorie in gutem Einklang zu stehen.

Die Emporwanderung der Elemente bzw. des Stoffes aus der Tiefe soll — nach Szádeczky — ständig abnehmen, weil die Energiequelle dieser Bewegung in Form des radioaktiven Materials in immer

geringerem Mass zur Verfügung steht. Nach der Expansionstheorie aber stellt die Wanderung des Stoffes einen stabilen Prozess dar, da die Menge der Energien, von denen sie aufrechterhalten wird, ebenfalls konstant ist. Wenn wir die durch archaische und neogaeische Orogenesen bewegten Massen in Verhältnis zur absoluten Dauer der beiden geologischen Abschnitten betrachten, sehen wir eher die letztere Ansicht bestätigt.

Die Konzentration der Elemente im Rahmen deren Wanderungen hat die Anreicherung gewisser Erze und sonstiger für das Wirtschaftsleben bedeutender Mineralien zu Folge. Es spielt sich aber der entgegengesetzte Prozess, die Zerstreung der Elemente auch fortwährend ab; während dies erhält der Ionisationsgrad einen vom Inneren der Erde in die Richtung der Oberfläche einen zunehmenden Charakter. Die Frage, ob die Konzentration der Elemente eine abnehmende Tendenz aufwiese, müssen wir in breiterem Zusammenhang betrachten, als es von Szádeczky's Auslegung hervorgeht. Es handelt sich nicht nur um die wiederholte Schmelzung und Anatexis der Gesteine, nicht bloss um die danach folgenden magmatischen Prozesse, die in einzelnen Teilen der festen Kruste zur »Selbstreinigung« zum »teilweisen Loswerden von den gebundenen Schwermetall-Atomen in Form von selbständigen Erzflözen« führen, sondern auch um die »Einfrierung« eines Teiles der Elemente durch die Wanderung in die grossen ozeanischen Becken und durch ihre Ablagerung in Form der roten Tiefseetone. Dieser Vorgang wird auch von Rankama's Beobachtung bestätigt, nach der die alten Magmatite mehr schweres sidero- und kalkophiles Element enthalten, als die entsprechenden jungen Magmagesteine. Unseres Erachtens lässt sich diese Tatsache dadurch erklären, dass in den Gebieten der jüngeren Eruptiven die feste Erdkruste im allgemeinen noch nicht bis zur Wurzelzone der Gebirge abgetragen worden ist.

Dieser Umstand führt uns zur Meinung, dass in den noch verborgenen Wurzelzonen der jungen Gebirge noch zahlreiche Liquefaktions- bzw. andere Anreicherung von Erzen und Elementen stecken können, die während der Regeneration der Erdkruste durch Anatexis, Magmatismus, und durch die Wechselwirkung anderer endogener Prozesse entstanden sind. Das lässt sich am besten ebenfalls durch die Expansionstheorie erklären. Es werden so auch die vom Festland abgetragenen 1, sich in den ozeanischen Becken ansammelnden und dort lange liegen bleibenden Sedimente wieder ersetzt.

Wie diesen riesigen Mengen der Sedimente der notwendige Platz gesichert werden kann, scheint ein neueres Problem darzustellen. Es mangelt aber eigentlich überhaupt nicht an Platz, denn die Tiefseebecken, als Sammler der Sedimente werden durch die Regeneration der sialischen Kruste nicht nur ständig aufrechterhalten, sondern sie nehmen an Ausdehnung scheinbar zu. Diese Zunahme findet ihre am meisten plausible Erklärung in der Espansionstheorie von L. Egyed.

Dieser Aufsatz bedeutet bloss eine skizzenhafte Zusammenfassung der Folgen der oberflächenformenden Prozesse. Das entworfene Bild wird durch die künftigen gründlichen Forschungen ganz gewiss vielfach verändert werden.

LITERATUR

- Bruns, E. (1958). *Ozeanologie*. I. Berlin.
- Bulla, B. (1954). Die Entwicklungsrhythmen der Festlandoberfläche. Vortrag in der ung. Akademie.
- Clarke, W. F. (1924). *Data of geochemistry*. 5th ed.
- Goldschmidt, W. M. (1926). Probleme und Methoden der Geochemie. *Gerlands Beiträge d. Geophys.* 15.
- Egyed, L. (1956). A Föld fizikája. *Physik der Erde*. Budapest.
- Kuenen, P. H. (1950). *Marine geology*. N. Y. — London.
- Rankama, K. (1946). On the geochemical differentiation in the Earth's crust. *Bull. Comm. Géol. Finlande*. 137.
- Szádeczky, K. E. (1955). *Geokémia. Geochemie*. Budapest.
- Verhoogen, J.—Turner, F. (1951). *Igneous and metamorphic petrology*. N. Y. — Toronto-London.
- Washington, H. S. (1925). The chemical composition of the Earth. *American Journal of Science* 9.

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DECLINE OF RAILROAD PASSENGER TRAFFIC IN MINNESOTA

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ABSTRACT

The study focuses attention on changes that have taken place in the passenger traffic of the Minnesota railroads by means of cross-sections of the situation prevailing in three different years (1934, 1956 and 1966). 1) Before World War II, when railroad passenger service was significant on both local and express lines, there was a clear linear, positive correlation between the total distribution of passenger traffic and population density on the county level («intrastate phase»). 2) Since the War the railroad passenger service has decreased drastically. Short branch and side tracks had their traffic reduced or discontinued, as the railroad companies lost out in competition to private automobiles. By studying the relationship between railroad and highway passenger traffic, it was seen that the railroad passenger service first began to undergo a steep decline both absolutely and relatively in the most populous and economically most advanced area of Minnesota. 3) By 1966 nearly all the remaining passenger service was that of long-distance express trains. Their traffic flow and direction is determined primarily on the basis of the location of metropolitan centers beyond the state boundaries («interstate phase»).

I. INTRODUCTION

1. THE AIM OF THE STUDY

The railroad is an inseparable part of the total image projected by the United States of America. The image of the West would be deficient if, in addition to the covered wagon, it did not include a locomotive and a long train of cars. The spread of settlement, the growth of population, industrialization and urbanization took place parallel with the expansion of the railroad network. Thus, it is no wonder that the regional expansion of the railroads which occurred during the last century, in particular, should have been the subject of many a learned paper. This is not, however, due solely to nostalgic admiration for an era lustrous with romantic color, but it also probably

reflects a certain feature characteristic of all scholarly research. The research scholar is always eager to attack a problem involving the phenomenon of *growth*. The railroad signified, furthermore, quite a *new* territorially influential factor. After the functional phase of the phenomenon under investigation is already underway, the researcher naturally concentrates on those aspects of the phenomenon that are estimated to be *important*. Accordingly, for the most part recent geographical studies in the United States dealing with railroads have been confined to freight traffic (e.g., Ullman 1957; Alexander *et al.* 1958; Wallace 1958, 1963, 1965), which constitutes the »principal role of a railroad in the Anglo-American railnet» (Wallace 1963, p. 312). By contrast, the phenomenon of *decline*, which characterizes the passenger traffic on American railroads, has been generally passed over in geographical literature with only a brief mention (Wallace 1958, pp. 357—359, 1963, p. 312; Walmsley 1965, pp. 1—6). Similarly, in those geographical studies of transportation proposing to develop models for the processes of change in networks, one finds only models for the growth of networks (Haggett 1967, pp. 642—646; Harvey 1967, pp. 564—568).

The aim of the present study is to elucidate regional features in the decline of railroads as passenger carriers, with the state of Minnesota being used as a sample area. Attention in the study is focused on the following three principal problems: 1) To analyze empirically and to describe the development in the volume of passenger traffic on the Minnesota railroads during the period 1934—1966. 2) To analyze quantitatively the data to reveal possible functional relationships between the decline in passenger rail service and the structure and magnitude of the areas. Special emphasis is given within the study to ascertain the correlation between the distribution of population, highway traffic and railroad passenger service. 3) To develop, on the basis of the findings and possible generalizations, a model that generally describes the declining role of railroads as regional passenger carriers.

2. THE GENERAL DEVELOPMENT OF PASSENGER TRAFFIC IN THE U.S.A.

When the first transcontinental railroad line reached the Pacific coast about 100 years ago (1869), the total rail network had increased to 46,844 miles (75,386 km). Thereafter the over-all length of the rail-

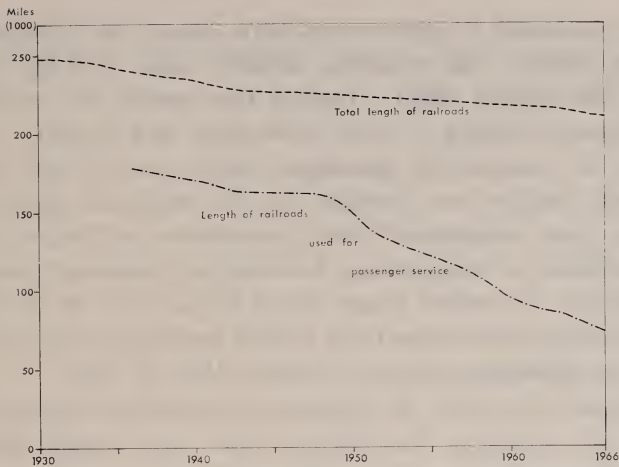


Fig. 1. Total mileage and passenger service mileage in the United States, 1936—1966.

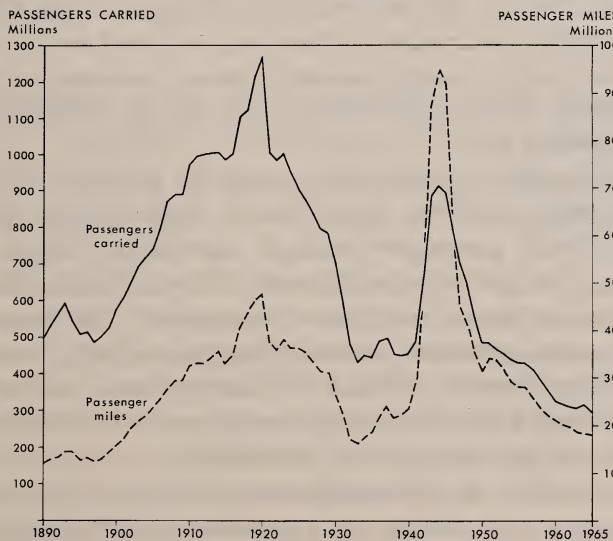


Fig. 2. Number of railroad passengers and passenger mileage in the United States, 1890—1965.

road lines continued to grow until 1916, when the all-time high for trackage in service was reached, 254,037 miles (406,459 km) (U.S. Bureau of the Census 1960). During that period the railroads were the predominant carriers of both passengers and freight. In 1916 98 per cent of all commercial passenger traffic and 77 per cent of the total intercity freight was handled by the railroads (Stover 1961, p. 238). They have maintained their importance as freight carriers to this day, whereas a conspicuous decrease in passenger transportation has taken place. In recent years, about 85 per cent of the revenue of American railroads has come from freight traffic and only about seven per cent from passenger service (Wallace 1963, p. 312).

The decline in the role of railroads as passenger carriers is demonstrated by, for example, the changes that have taken place in the facilities for passenger service as reflected in data covering the period back to 1936 (Fig. 1). There has been a slight decrease in total trackage, corresponding to the over-all trackage in freight service, since 1916. But, on the other hand, the trackage operated in passenger service, in addition to the transportation of freight, has decreased drastically during the past fifteen years. In 1936 seventy-one per cent of the trackage was also used for passenger transportation. In 1950 the corresponding figure was only slightly lower (61.3 per cent), whereas in 1965 it was as low as 36.4 per cent (U.S. Bureau of the Census 1960, 1965, 1967). This examination of the situation, based as it is on railroad mileage, gives only a rough general picture, however, of the course of developments. The picture can be given clearer definition by adding passenger statistics to it.

The peak number of passengers carried by American railroads was recorded in 1920, when the figure rose to 1,200 million (Fig. 2). In recent years the passenger mileage has fallen below the passenger mileage of all the years between the two World Wars, except for several years during the Great Depression. The reason for this is that the average distance traveled has substantially increased. In 1920 the average distance traveled by passengers on the railroads was 37 miles (60 km), whereas in 1965 the distance was 58 miles (94 km) (U.S. Bureau of the Census 1960, 1965, 1967).

The whole decline of the railroad passenger service has taken place, moreover, during a time when the population of the United States and its mobility were greatly increasing. Other forms of transportation must therefore have superseded the railroads as passenger carriers.

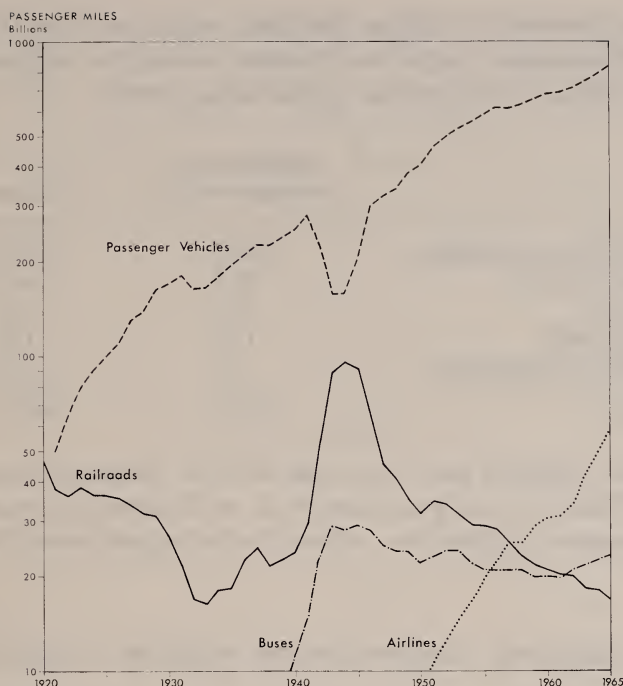


Fig. 3. Travel by private and public carriers in the United States, 1920–1965.

A clear conception of this can be gained by comparing intercity passenger travel (expressed in passenger-miles) by private and public carriers (Fig. 3) (U.S. Bureau of the Census 1960, 1965, 1967). In 1920 nearly one-half of all the passenger traffic was handled by railroads, as expressed in terms of passenger-miles. Private automobiles accounted for approximately an equal volume of traffic. Since then the volume of private automobile traffic has increased very rapidly. This is also reflected in the registration of motor vehicles in the United States (see, e.g., Christensen 1966, p. 340). Since World War II passenger automobile traffic has grown relatively in the same proportion as railroad passenger transportation has decreased, as clearly shown by the curves in the logarithmic scale (Fig. 3). In 1957 also the airlines surpassed the railroads in passenger transportation and at present carry three times as many passengers. During the present decade the bus lines have likewise surpassed the railroad lines as passenger carriers,

although no increase in volume has been registered since World War II. In 1965 passenger traffic was divided among the various types of carriers as follows (U.S. Bureau of the Census 1966):

	Billions of passenger-miles	Per cent
Private automobiles	838.1	89.2
Air carriers	58.1	6.2
Buses	23.1	2.4
Railroads	17.6	1.9
Inland waterways	3.1	0.3
Total	940.0	100.0

Thus, the railroads have not been able to compete successfully in the United States for the passenger trade with newer and more flexible forms of transport during the current technological revolution.

3. THE RAILROAD TRANSPORTATION POSITION OF MINNESOTA

All the data relating to the railroads of the United States as a whole are not available broken down into separate packages for the several states. This is partly because the majority of the railroad companies operate over areas covering many states and cannot easily break down their statistics in accordance with state boundaries. Then, since the railroad companies are private business enterprises in competition with each other, they are by no means eager to disclose information concerning local stretches of track. Consequently, a complete analysis of Minnesota's position in the transportation system and a comparison with the situation prevailing in the country as a whole on a statistical basis is not possible.

A comparison of the partly unpublished data obtained from the Railroad and Warehouse Commission of Minnesota with figures applying to the country as a whole, however, reveals that during the present century the trackage in operation in this state has remained nearly unchanged in relation to the rest of the country.

Similarly, the fluctuations in railroad passenger traffic adhere fairly closely to those registered for the country as a whole (Fig. 4) (U.S. Bureau of the Census 1960, 1965, 1967; State of Minnesota, Railroad

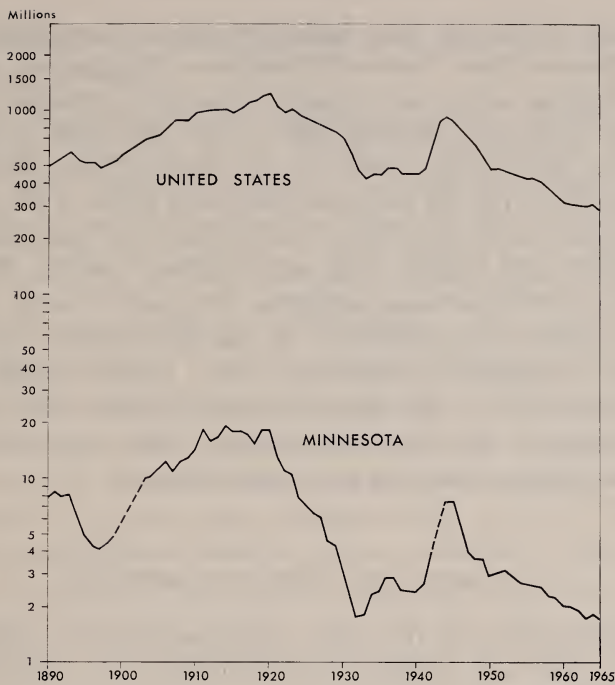


Fig. 4. Total railroad passengers in the United States and Minnesota, 1890—1965.
(Broken line: no data.)

and Warehouse Commission, unpublished data). This line of development is actually quite understandable, inasmuch as Minnesota encompasses a sufficiently large area and its rail network may be structurally considered to correspond in many ways to the national network on a minor scale. Within the state it is possible to distinguish areas marked by a sparse network and other areas marked by a dense network. In addition, the state is crossed by transcontinental tracks typical of the country as a whole (cf., Ullman 1957, p. 3). Minnesota thus affords a highly interesting and sensible point of departure for a regional study of the decline in railroad passenger service.

A more detailed examination of the trends in the volume of passenger traffic in Minnesota brings to light the fact, however, that the changes in this state have been greater than on the average in the country as a whole (Fig. 4). For example, during the last decade the number of passengers traveling by rail in Minnesota decreased more than on the average throughout the United States. This is due, at

least in part, to the fact that Minnesota has no megalopolis on the order of Boston—New York—Philadelphia—Washington, where the railroad to this day serves an important function in transporting masses of commuters daily (e.g., Wallace 1958, p. 357; Neft 1959, pp. 151—163). Although the metropolitan area of the Twin Cities boasts over a million inhabitants, private cars claim the lion's share of the city traffic. The hinterland situation of the Twin Cities, the existence of two separate and nearly equally important business centers (Minneapolis and St. Paul), and the decentralization of places of work have contributed to prevent the swelling of the parking problem, for instance, to the worst American proportions. The present study therefore escapes involvement in the kind of traffic problems that plague the urban complexes in the true megalopolitan class and in the solution of which the railroad still plays an important part.

4. SOURCES AND RESEARCH METHODS

The basic material for the study originates from the Official Guide of Railways. The data obtained from this source may be divided into two main categories:

1. From timetables one can ascertain the *numbers of passenger trains* operating on the different tracks in specific units of time. This information yields quite a good picture of the directions of traffic flow. The numbers of trains running can also be used as a rough measure of the volume of traffic flow. For this purpose, information on the numbers of passengers traveling on the different lines would, of course, prove more enlightening; but information of this nature is impossible to obtain, particularly as it pertains to earlier periods.

Although the numbers of passenger trains in service give only a rough idea of the volume of passenger traffic, indicating, in fact, only the passenger service potential on the different sections of the network, this information nevertheless has a certain value specifically in the field of research into the decline of passenger traffic. Changes in the numbers of passengers boarding trains are bound to be reflected fairly quickly in the numbers of trains put into service, for American railroad companies are private business enterprises operated on the profit principle. For this reason, their operations are not determined by complicated social or political behind-the-scenes factors, as in

countries where the railroad systems are owned by the state and run by the government.¹

2. From the timetables one can also count the *numbers of station stops* made by passenger trains. Much as the numbers of passenger trains can, with certain reservations, be used to measure the traffic on the various lines, the numbers of stops can be used as a measure of passenger traffic by the station. Ascertaining the numbers of passengers by the station is not possible, for the railroad managements regarded such information, too, as belonging in the sphere of business secrets. Thus, when at a certain station (Alexandria) one summer day I asked how many tickets had been sold, I was given no answer.

In geographical traffic studies, a density ratio (length of the rail system : area) has ordinarily been used as a measure in comparing the traffic density of various areas (Haggett 1966, p. 237). This is quite a serviceable procedure in dealing with, e.g., highway traffic, where the motorist can join the traffic flow at practically any point whatsoever. With respect to railroad passenger traffic, on the other hand, the situation is different. The density ratio calculated by applying the length of tracks does not yield a true picture, for it is possible to board and leave a train only at some station. For this reason, in the present study the point of departure will be the density of stops (number of stops : area) in investigating changes in passenger traffic in small areas as well as in investigating the correlation between traffic density and various territorial factors.

¹ In this connection it should, however, be pointed out that the railroad companies of Minnesota are not at liberty to curtail train services completely at their own discretion. All moves by the railroads to reduce passenger train schedules had been subject to ratification by the State Railroad Commission. The commission decided each case separately in accordance with the statute of 1921, which vaguely sanctioned reductions »where the service was more than the situation reasonably required.« In practice the commission had generally sanctioned reduction of service in areas where after such a reduction other public transit facilities remained in operation (street railways or buses). Examples of the commission's decisions in certain individual cases are cited in another connection (Kaups and Rikkinen 1968).

The Transportation Act of 1958 granted the Interstate Commerce Commission jurisdiction over interstate railroad passenger train service abandonments. In practice this law proved of great significance, for it has helped railroads to discontinue unprofitable interstate passenger trains (cf., Kaups and Rikkinen 1968).

The study focuses attention on changes that have taken place in the passenger traffic of the Minnesota railroads by means of cross-sections of the situation prevailing in three different years. These years are 1934, 1956 and 1966. The numbers of trains and stops on Mondays were determined for the period January to May. Monday was chosen because it conformed well to an average passenger day, and the winter months were used because during the summer there have been many periods when the schedules were altered for special services. The last of the years, 1966, represents the last annual period providing the necessary data. The choice of the year 1956 is due to the fact that it represents the situation prevailing just before the Transportation Act of 1958 took effect, legislatively facilitating the reduction of passenger service on the railroads (cf., footnote 1). The year 1934 represents the situation obtaining prior to the outbreak of World War II, a time when a heavy decrease had taken place in the numbers of passengers riding trains but not a single railroad had as yet entirely discontinued its passenger service in the state of Minnesota. The early stages in the decline of railroad passenger traffic prior to 1934 are dealt with in greater detail in another paper (Kaups and Rikkinen 1968), so in the present work the period in question will be touched upon only briefly.

II. RAILROAD PASSENGER TRAFFIC IN 1934

There took place a substantial decrease in the number of passengers riding on railroad trains in the state of Minnesota between 1920 and 1934 (Fig. 4). It was during that period that the competition among the railroads, bus lines and private cars may be considered to have started. In traffic between Minneapolis, St. Paul and Duluth, street railways also figured prominently in those early days. Detailed examples of the competitive activity in its early stages are presented in a different connection (Kaups and Rikkinen 1968). The effects of the competition on the railroads led to their filing between 1920 and 1934 as many as 81 petitions to the State Railroad Commission to reduce service, with 62 of the petitions being approved (State of Minnesota, Railroad and Warehouse Commission, 1920—1936). In practice, the railroads reduced the frequency and length of passenger trains, and passenger trains were changed to mixed passenger-freight trains. Further, schedules were cut, and in some cases railroad managements installed bus transportation of their own. Although passenger traffic dwindled during this time, passenger service had not been discontinued completely on a single rail line up to the year 1934.

1. THE RAILROAD SYSTEM AND TRAFFIC DENSITY, 1934

The Minnesota rail network in 1934 is shown in the accompanying map (Fig. 5), along with the numbers of passenger trains operating on the different routes daily. Almost without exception, the passenger trains traveled back and forth on their routes, which means that the number of trains must generally be read in pairs. Only certain long-distance trains followed different routes on their night and their day runs.

The Twin Cities (Minneapolis—St. Paul) formed a distinct nucleus in the rail network, with tracks radiating from this center in all

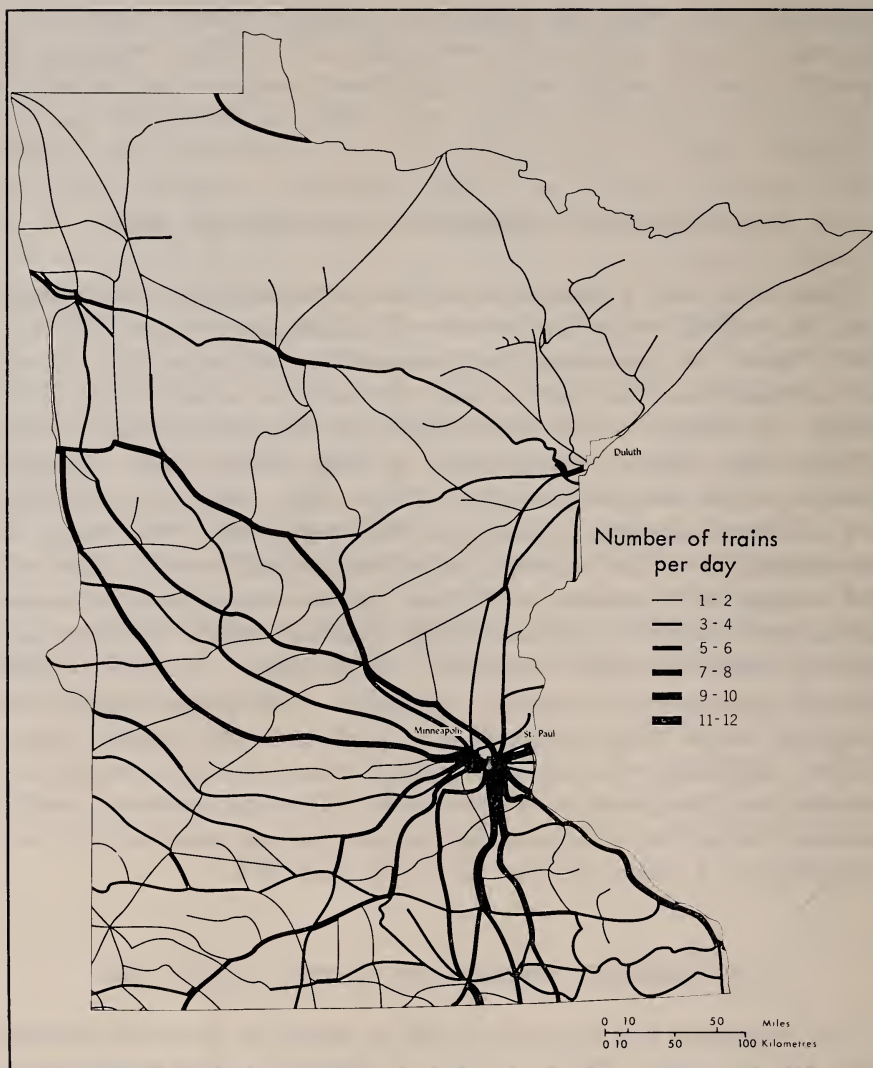


Fig. 5. Number of passenger trains daily in Minnesota, 1934.

directions. The routes can be divided on the basis of their density and the average distances between trains in operation into four main types, between which, however, no rigid lines can be drawn:

- 1) The heaviest traffic occurred on certain long-distance lines,

which ran through a number of different states. Among the most important of these were the transcontinental lines running across Minnesota in a southeast-northwest direction, which connected the great cities of the eastern seaboard via Chicago and the Twin Cities with the Pacific coast. The main rail lines leading southward terminated in St. Louis. The line running from the Twin Cities toward the southwest made a connection with Kansas City via Sioux City (Iowa). The group of long-distance lines also includes the route owned by the Canadian National that cuts across the northernmost part of Minnesota. All the aforementioned routes scheduled more than five trains daily.

2) The second heaviest traffic occurred on the medium-distance connecting lines, which ran between the long-distance tracks and joined them. In this category may be included also the connecting lines between Duluth and the Twin Cities. At least three passenger trains a day were on the schedules of these lines.

3) In addition, there was a large number of short connecting and branch lines on which only one passenger train ran in each direction daily. Most of these routes were local in character.

4) Among these lightly traveled tracks, separate mention should be given the ones running across northern Minnesota that connected the transcontinental lines of the United States and Canada. Although the passenger trains operating on them in 1934 were few in number, these tracks were all the more important because there were not many lines of communication between the United States and Canada (Wolfe 1962, p. 184).

With respect to the structure of the rail system, quite special attention is commanded by the fact that in the chief traffic sectors, such as, e.g., the transcontinental axis and the zone between the Twin Cities and St. Louis, several lines in active operation were situated very close together. This is explained by a certain feature characterizing the railroad system of the United States as a whole — the motley nature of company ownership. In 1934 Minnesota had a total of thirteen railroad companies engaged in commercial passenger transportation. The smallest of the companies owned but a single short, local line of track. On the other hand, the trackage operated by the big companies, like the Great Northern, the Northern Pacific and the Milwaukee Road, extended beyond Minnesota into the territory of many another state. These rival companies had built their own tracks

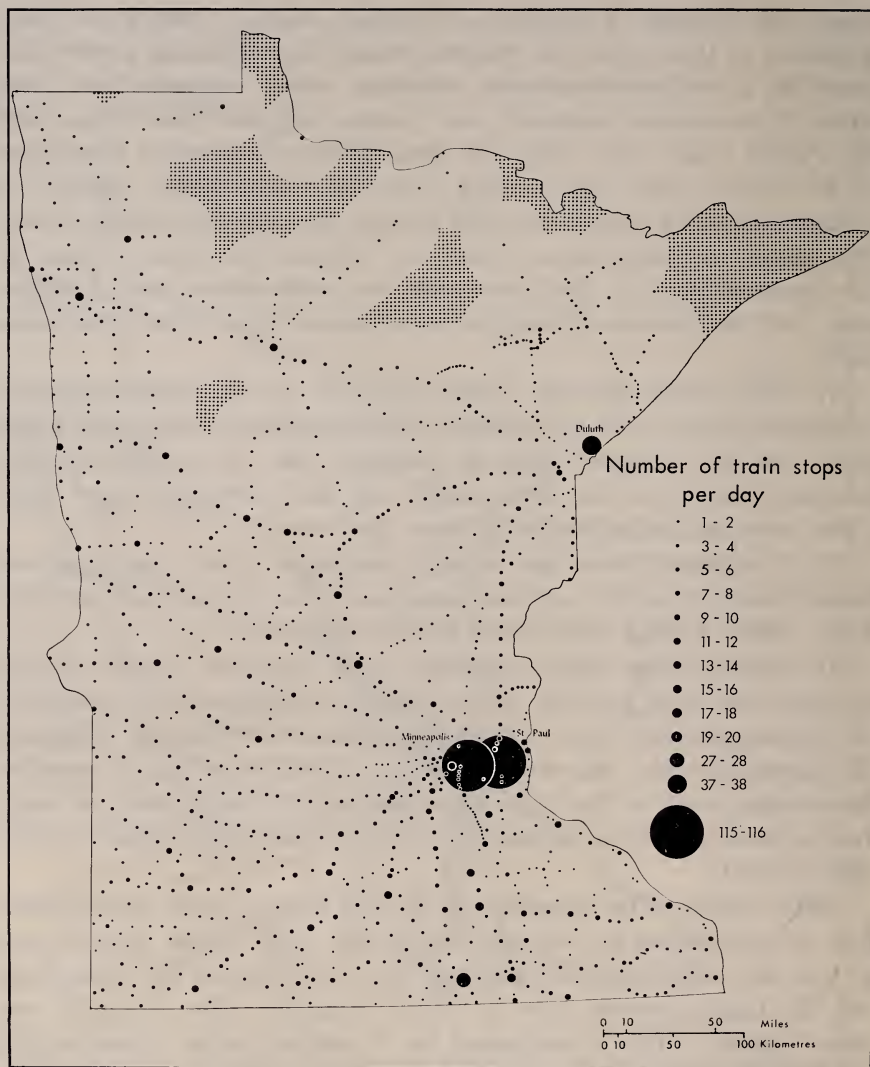


Fig. 6. Number of passenger train stops a day in Minnesota 1934. In shaded areas, distance to nearest station is over 20 miles.

on the main routes, with the result that the 1934 map shows them clearly as separate lines running parallel to each other.

In 1934 Minnesota had a total of 1,067 railroad stations handling passengers (Fig. 6). The trains at that time made a total of 3,859

Table 1. Number of daily stops by passenger trains in Minnesota, 1934.

Number of stops	Stations	Per cent	Stops	Per cent
1—2	578	54.2	1 136	29.4
3—4	334	31.3	1 272	33.0
5—6	89	8.3	519	13.4
7—8	22	2.0	173	4.5
9—10	18	1.7	178	4.6
11—12	13	1.2	155	4.0
13—14	5	0.5	69	1.8
15—16	4	0.4	63	1.6
28	1	0.1	28	0.7
38	1	0.1	38	1.0
112	1	0.1	112	2.9
116	1	0.1	116	3.0
Total	1 067	100.0	3 859	100.0

stops a day. Also cases where the trains stopped only when necessary as well as so-called flag-stops have been included in the count. Table 1 shows the numerical proportions between stations and train stops.

More than one-half (54.2 per cent) of the stations were of the kind at which trains made only one or two stops daily. There was also quite a large number of stations at which trains stopped three or four times a day. Stations handling less than five daily train stops accounted for 85.5 per cent of the total number of stations as well as 62.4 per cent of the total number of stops made. The stations carrying the biggest passenger load were situated along the main long-distance routes, and they were generally junction stations. In Minneapolis and St. Paul, 228 stops were generally made daily. (Only the stops made at the central stations in these cities are included in the count). After the Twin Cities, the next most important station was Duluth, which was really a terminal station.

Territorially viewed, the southern, central and western parts of Minnesota were covered by a dense network of stations. The distance to the nearest station was nowhere over ten miles. By contrast, in the northern and northwestern parts of the state, the network of tracks and stations was much sparser. There was an exceptionally dense group of stations, however, on the northern side of Duluth,

in the Iron Range mining country. In northern Minnesota, fairly extensive areas can be observed where people had to travel more than 20 miles (about 30 km) to reach the nearest rail station.

The demarcation zone that divides Minnesota into two parts on the basis of train stops adheres fairly closely to the boundary between the southern farming country and the northern forest country (National Atlas of the United States 1950). At the same time, the volume of passenger traffic on the railroads seems to be in correlation with many of the population and economic features of Minnesota. Thus, there is a visual similarity between the map showing the density of train stops (Fig. 6) and the dot distribution map (Broek 1965, p. 35) correspond, visually considered, very closely with each other. This observation provides an inducement to delve deeper into the relationship between these two distributions.

2. THE RELATIONSHIP BETWEEN RAILROAD PASSENGER SERVICE AND POPULATION DENSITY

A simple linear correlation has been made to ascertain the relationship between railroad passenger traffic and the distribution of the population. The result would vary dependent upon the size of the statistical unit used as the basis in calculating the correlation. For this study the county has been chosen because it constitutes the most important local administrative unit. Use of counties as units for analysis presents problems owing to their unevenness in size; problems difficult to solve (Robinson 1956, pp. 233—236). But counties do not differ so much in area as to preclude giving significance to the rough figures obtained analytically. The difference in comparison to the true results is not very great.

Minnesota has a total of 87 counties. Six of the counties (Anoka, Carver, Dakota, Hennepin, Ramsey and Washington) have been combined into a single regional unit called the Twin Cities Metropolitan Area (TCMA). Within this area lives about one-third of the population of the state. Thus, as the principal urban center with traffic problems of its own, it constitutes an area deviating to such an extent from the rest of the state as to warrant its being left out of the statistical survey to follow. The number of units to be analyzed is therefore 81.

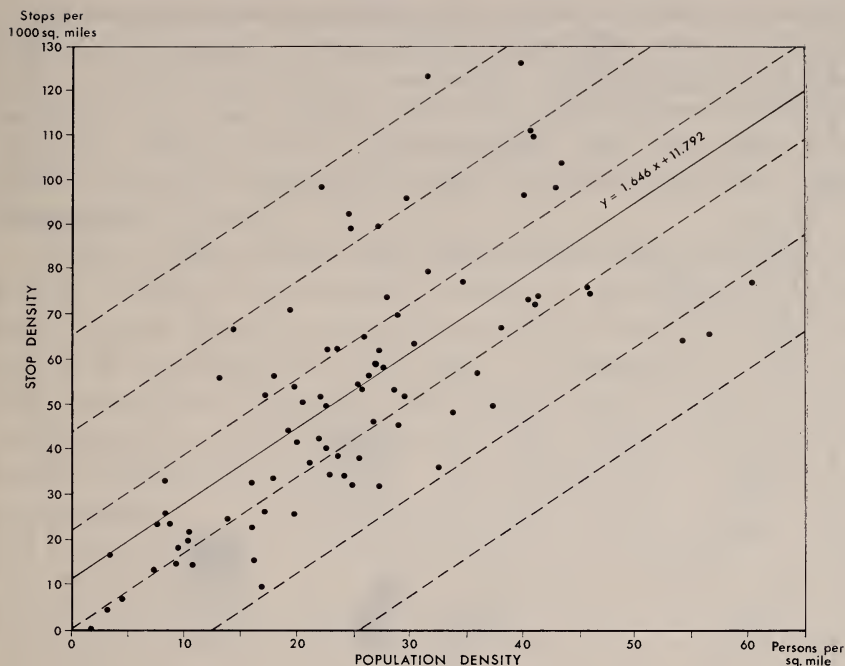


Fig. 7. Relationship between passenger train stop density (1934) and population density (1930) by counties in Minnesota.

The volume of passenger traffic on the railroads is reflected in the density of station stops by counties in 1934. The distribution of the population, again, is represented by the density of the population registered by counties according to the census of 1930. The fact that the data are from different years has no practical significance in this connection, for the changes in population during this four-year period are slight.

The relationship between these two distributions is presented as a scatter diagram in Figure 7. The simple linear correlation $r = +0.66$ is statistically highly significant at the 0.1 per cent level. The explained variation $r^2 = 0.436$, or approximately 44 per cent of the total. The regression line has been drawn on the basis of the computed values. The regression equation minimizing the sum of the square deviations of the actual values is of the form $y = 1.646x + 11.79$, where y is the stop density and x the population density.

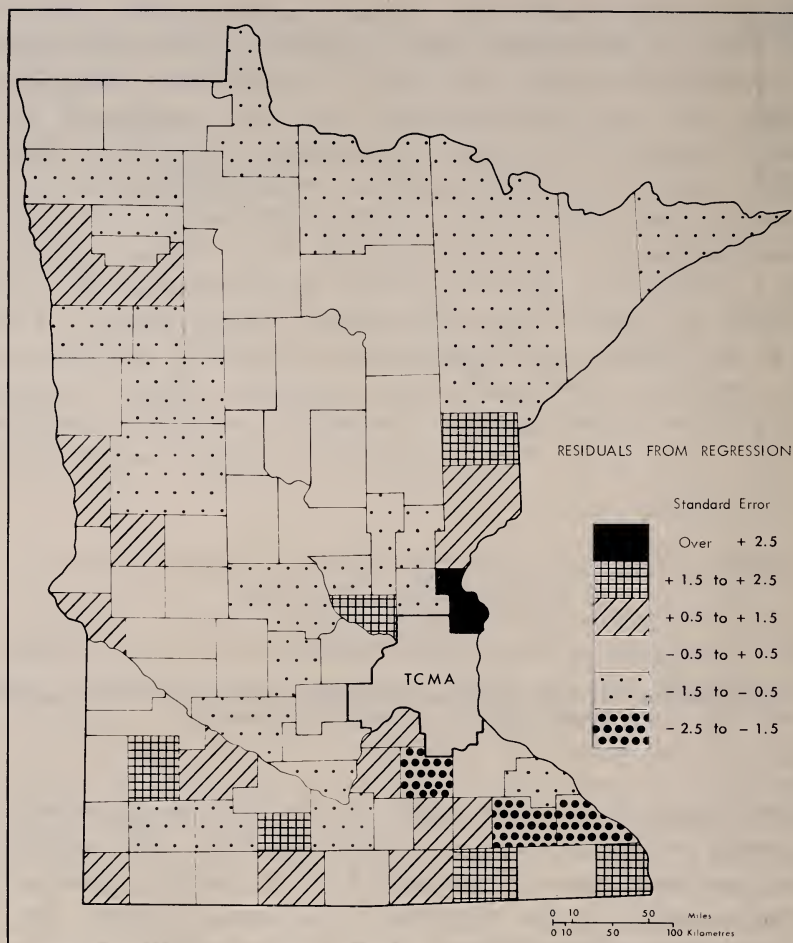


Fig. 8. Residuals from regression in Figure 7, measured in units of the standard error of estimate. TCMA = Twin Cities Metropolitan Area.

The rather low explanation percentage and the dispersion of certain points fairly far from the regression line on either side of it give rise to the assumption that, in addition to the population density, there might exist some significant extra forces, which might explain the matter better. Residuals from regression have been plotted cartographically to facilitate the interpretation of the large deviations from the regression line (Thomas 1960; Robinson *et al.* 1961).

The standard error of estimate (S_y) is 21.5. In Figure 7 on either side of the regression line, parallel bands have been drawn equal first to one half, and then to one whole, standard error of estimate. Deviations from the regression line have been plotted within these categories (Figure 8) and point up those areas that have a stop density greater or smaller than might be expected from the average relationship.

Of the counties where there were substantially more than the average number of train stops in relation to population (a standard error of more than 1.5), three occur in the vicinity of Duluth and four in the southern part of the state. A comparison of these areas with the previously presented maps (Figs. 5 and 6) reveals that the counties with a higher than normal traffic density are all situated around important rail junctions. The railroads seem to become more concentrated in the proximity of junction stations, and the station and train stop densities thus understandably increase on the average. The same holds true of the areas where the density of train stops exceeds the 0.5—1.5 standard error. There are only three counties where the train stop density is appreciably below the average (a standard error of more than 1.5). They are all counties with a small area south of the metropolitan district. As a matter of fact, these counties, too, are situated in the immediate sphere of influence of important through routes; but they happen to fit between parallel lines in such a way that their statistical area does not contain as many stations or include as many train stops as their population density would presuppose. Most of Minnesota is such that the deviations on each side of the regression line are not very large.

The final result of the foregoing review is that much of the variation in stop density may be explained in terms of differences in population density. By mapping the residuals of regression in terms of standard error, one can see that the greatest deviations are explicable in the light of natural circumstances relating to the structure of the rail network. Thus, the residual map suggests no such additional factors as might provide material for continuing the analysis on a multiple-regression basis. The same sort of final result was arrived at with a parallel analysis in which the relationship between stop density and population distribution was studied by applying absolute numbers in place of density figures.

Thus, the total distribution of passenger traffic on the Minnesota railroads in 1934 fairly closely corresponded to the general distribution of the population, although the growth of highway traffic, especially after 1920, had obviously weakened the correlation. The situation in 1934 well reflects the features of the pre-motoring era, when railroad passenger service was of great significance on both local and express lines. The situation may accordingly be regarded as a suitable point of departure for a survey of future developments.

III. CHANGES IN RAILROAD PASSENGER TRAFFIC, 1934—1956

The number of passengers carried by railroad trains in Minnesota was nearly the same in 1956 as it had been in 1934 (Fig. 4). In 1934, before the country had recovered from the crippling effects of the Depression, the number of passengers totaled 2.4 million. During World War II passenger traffic increased, however, temporarily. Notwithstanding the fact that passenger traffic in the years 1934 and 1956 was nearly the same, great changes took place in its territorial structure during the interim. Following the war, the competition put up by private motoring and commercial airlines increased (Fig. 3). This forced the railroads to improve the speed and comfort of passenger trains, reduce fares and discontinue lines that had become unprofitable.

1. CHANGES IN NUMBER OF TRAINS

The map depicting the numbers of train runs daily in 1956 (Fig. 9) differs considerably from the corresponding map dating back to 1934 (Fig. 5). To facilitate the making of comparisons, a map has also been drawn to show the changes that occurred in the numbers of trains scheduled during the period between these years (Fig. 10).

A comparison of these three maps yields the following observations concerning the different types of lines:

- 1) The main express lines, the transcontinental routes between Chicago and the Pacific coast, maintain their importance. The long-distance connection between the Twin Cities and St. Louis likewise remained important, though now the heavy traffic was concentrated on just one of the company's routes. On certain routes, like the one between the Twin Cities and Chicago, the number of trains even increased. The additional train runs on short sections of track along the western and southern boundaries of the state were due to the fact

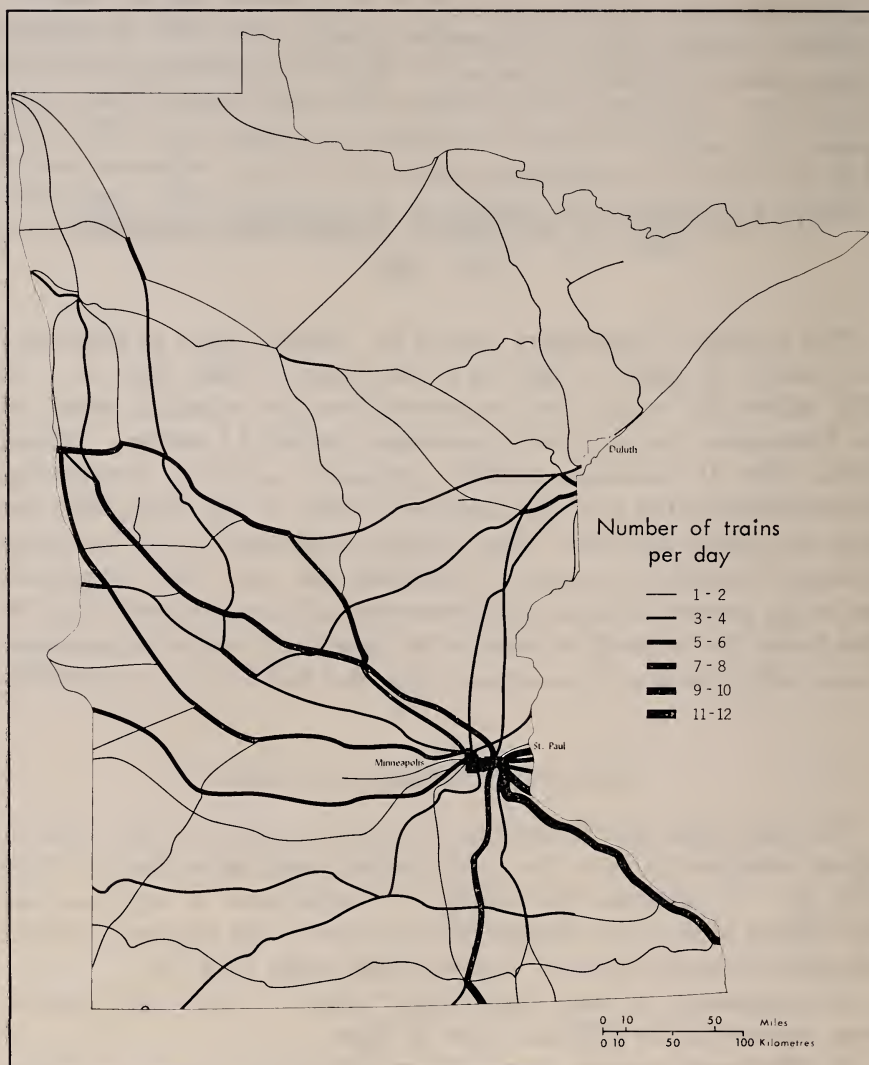


Fig. 9. Number of passenger trains a day in Minnesota, 1956.

that the speed of express trains on long-distance lines was raised by straightening out their routes. Such accelerations of the timetables could be carried out only by the biggest companies, which had at their disposal alternative tracks.

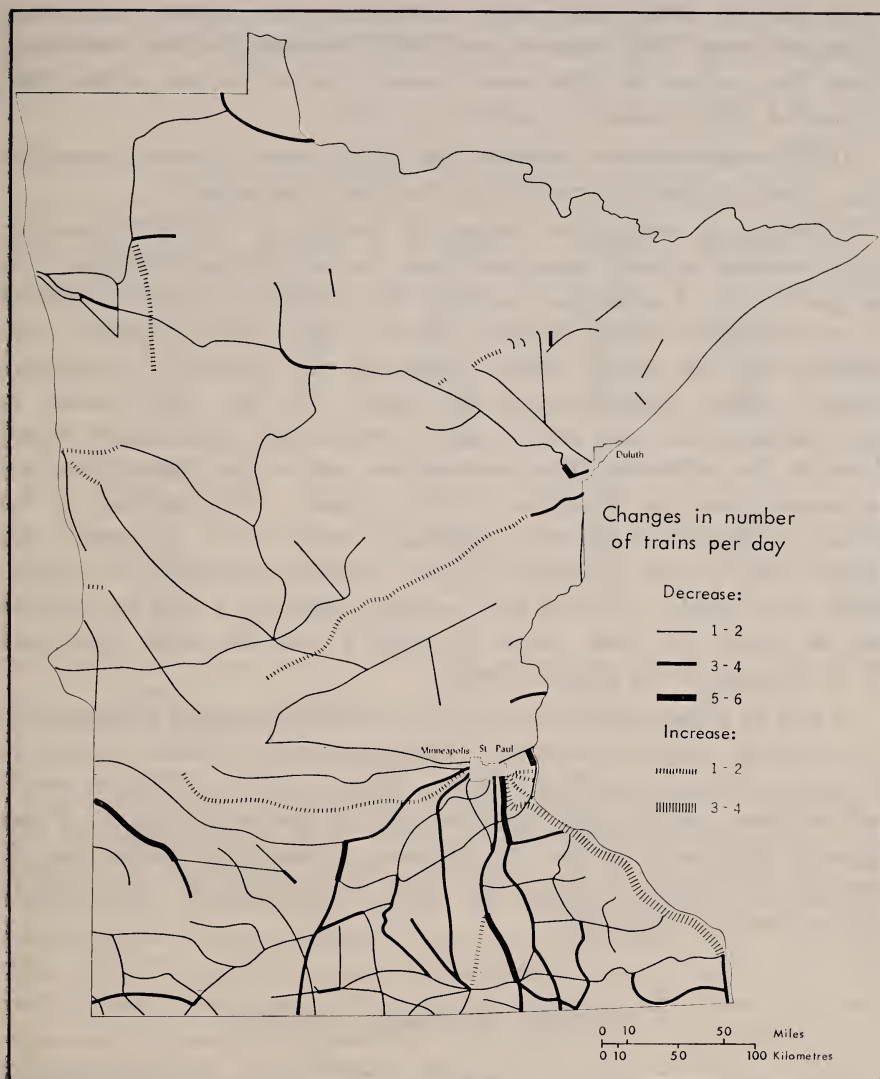


Fig. 10. Changes in number of trains a day in Minnesota, 1934—1956.

2) Also the majority of the medium-distance combined tracks retained their importance. Duluth retained its good connections with the Twin Cities and direct connections with the transcontinental lines even increased in number.

3) On the other hand, short connecting and branch tracks discontinued many train runs up to 1956. Practically all of the many trains that as late as 1934 made round trips on routes of less than a hundred miles ceased to operate on them.

4) The connections between the U.S.A. and Canada consisting of a single round-trip run daily remained unchanged.

Taken as a whole, the center of gravity of railroad passenger traffic seemed to shift more and more to long-distance service. On the part of this long-distance service, the tendency could be observed of concentrating traffic on ever fewer main tracks, together with speeding up the trains, which improved the railroads' competitive position against highway and air traffic. On the other hand, in local traffic private cars and, to some extent, buses had already forged ahead of the railroads. The metropolitan area of the Twin Cities and its vicinity was no exception in this respect. The shifting of the center of gravity of railroad passenger service over to longer and longer runs is also witnessed by the statistics covering the United States as a whole. In 1934 the average length of a trip by railroad was 40 miles (64 km), while in 1956 it was 65 miles (105 km) (U. S. Bureau of the Census 1960).

It will be observed in surveying the territorial expanse of Minnesota in its entirety that the decrease in train schedules had been greatest in the region south of the Twin Cities, where as late as 1934 the traffic had still been livelier than anywhere else in the state (Fig. 5). These regional differences in the development of passenger traffic can be considered in more detail in the light of the changes occurring in the numbers of train stops.

2. CHANGES IN NUMBER OF STOPS

The number of railroad stations in Minnesota at which passenger services were available had dwindled by 1956 to 681, which was only 64 per cent of the 1934 figure (Table 2). In other words, 386 stations had ceased to handle passenger traffic. At the same time, the number of daily stops decreased by over a half (53.5 per cent). The biggest reduction took place among the stations which had handled more than two daily stops. The share of stations taking care of one or two stops a day remained nearly the same. Relatively speaking, the

stations at which the number of stops had been reduced to a minimum handled a substantially bigger share in 1956 than they had in 1934 (Table 2).

Table 2. Number of daily stops by passenger trains in Minnesota, 1956.

Number of stops	Stations	Per cent	Stops	Per cent
1—2	518	76.1	1 011	49.0
3—4	106	15.6	412	20.0
5—6	31	4.6	184	8.9
7—8	9	1.3	72	3.5
9—10	4	0.6	39	1.9
11—12	6	0.9	72	3.5
13—14	2	0.3	26	1.3
15	1	0.1	15	0.7
20	1	0.1	20	1.0
26	1	0.1	26	1.3
92	1	0.1	92	4.5
94	1	0.1	94	4.5
Total	681	100.0	2 063	100.0
Per cent of 1934	63.8		53.5	

It is clear that the changes in the number of stops (cf., Figs. 6 and 11) corresponded fairly closely to the changes taking place in the numbers of train runs (Figs. 5 and 9). On short branch and side tracks, where the passenger service was totally abandoned, the stations naturally also became deserted as far as passengers were concerned (Fig. 12). In addition, certain small stations along routes with lively traffic were shut down. This trend stemmed from the previously discussed endeavor to speed up and improve the competitiveness of express trains on long-distance lines.

To ascertain how the numbers of stops changed areally, the percentage change in the number of stops was calculated by counties (Fig. 13). The frequency of stops decreased the most in the southern part of Minnesota — on the average, over 60 per cent. This was densely settled country, where short local lines were abandoned in great numbers (Fig. 12). In the central portions of the state, abandonment of service was less frequent, or, on the average, 40 per cent.

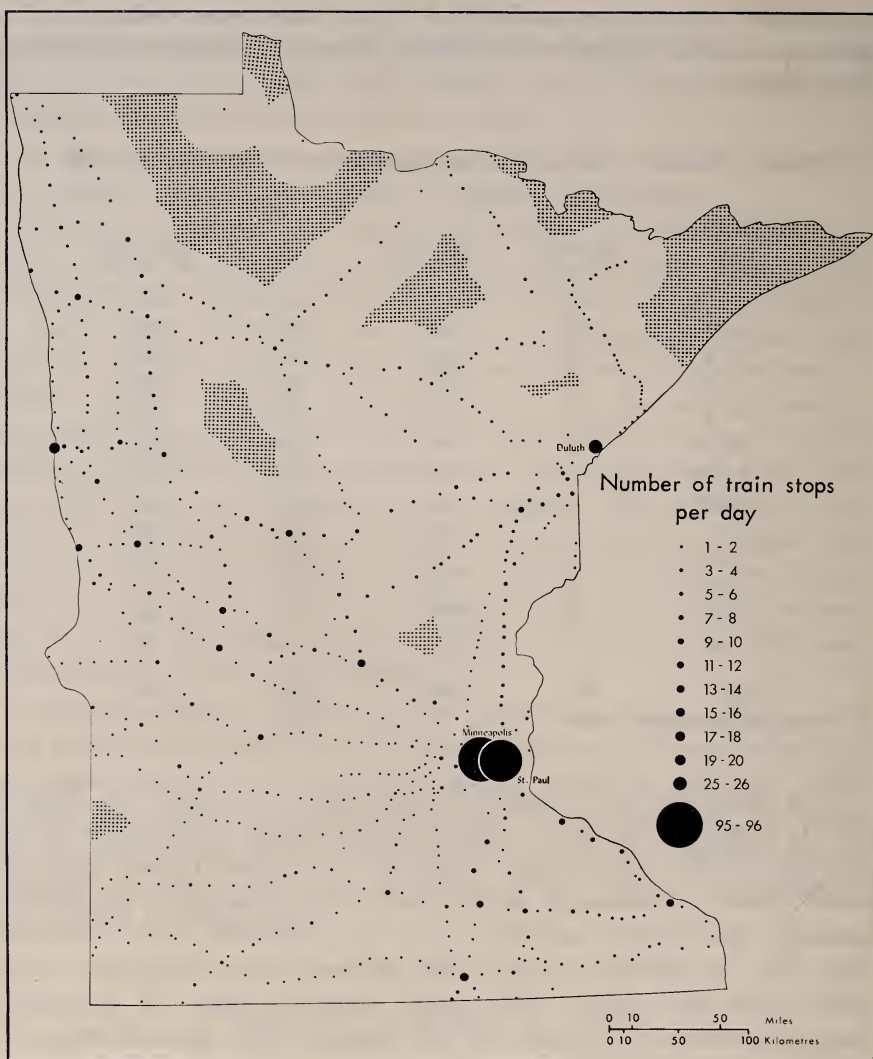


Fig. 11. Number of passenger train stops daily in Minnesota, 1956. In shaded areas, distance to nearest station is over 20 miles.

In northern Minnesota, where the counties are larger in area, the changes in the frequency of train stops varied. But since traffic in the north was slight, even minor changes signified large percentage changes. The greatest reduction occurred in the two northernmost

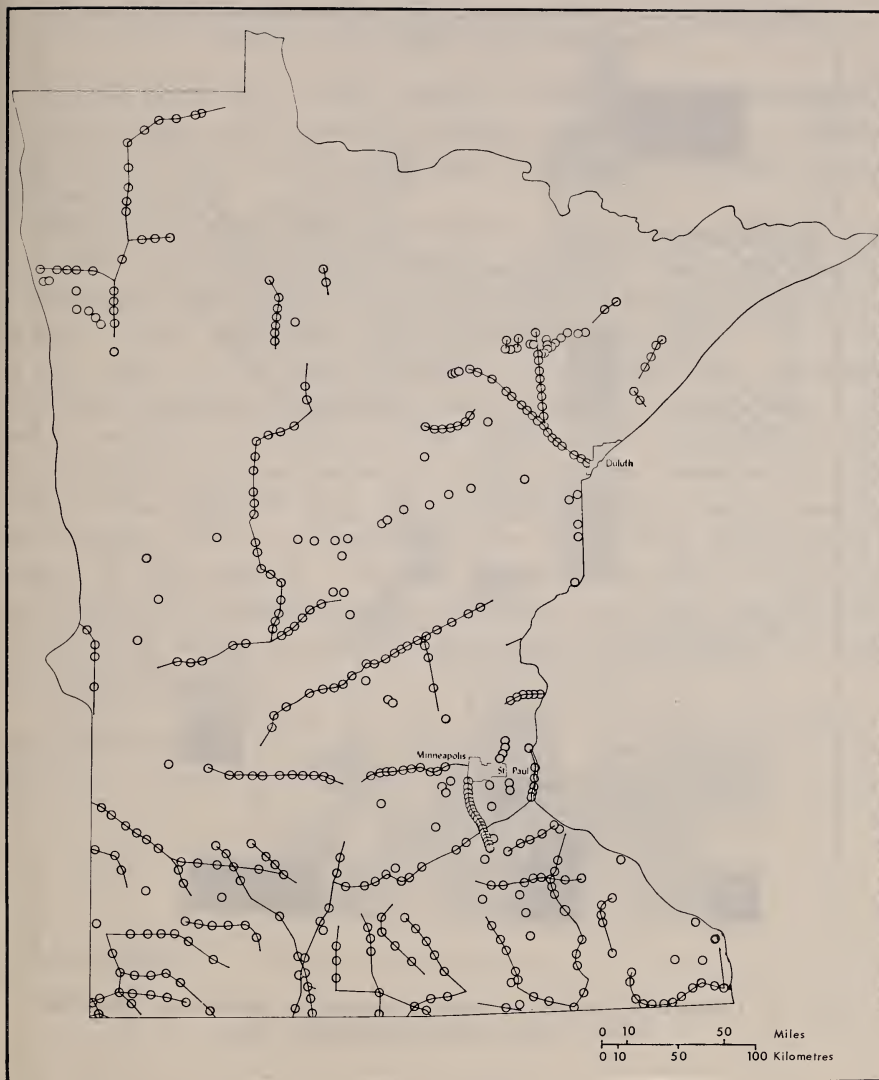


Fig. 12. Abandoned passenger stations and train services in Minnesota, 1934—1956.

counties, through which runs the line belonging to the Canadian National. In three counties, the number of stops increased on account of changes in the routes traveled by certain long-distance express trains (cf., Fig. 10).

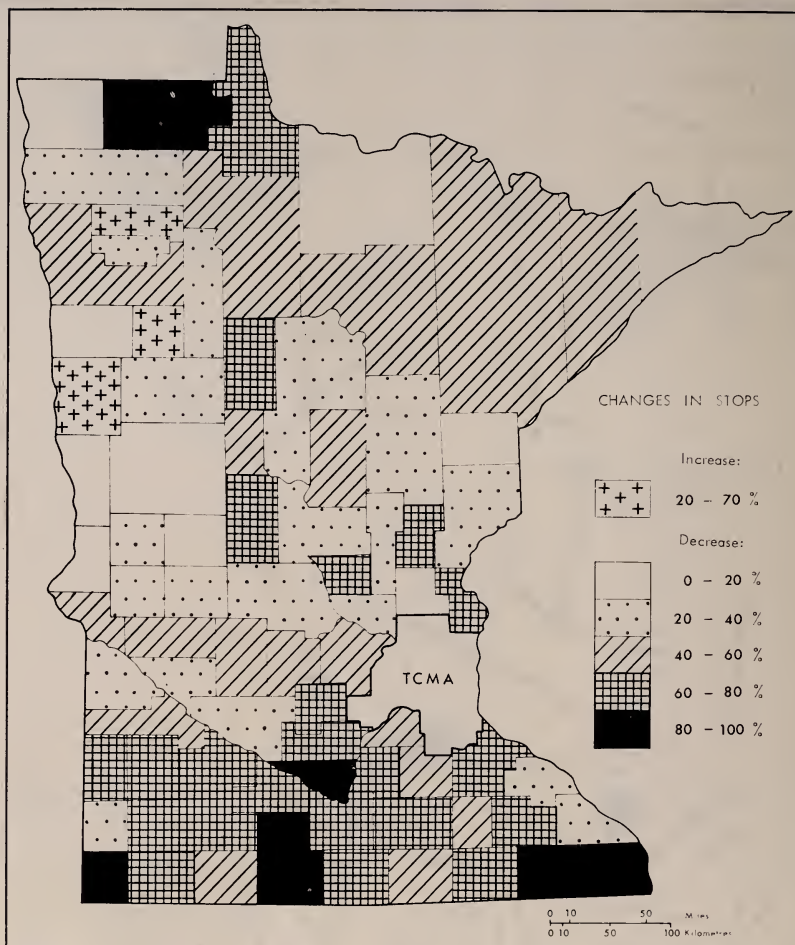


Fig. 13. Changes in number of stops by counties in Minnesota, 1934—1956.
 TCMA = Twin Cities Metropolitan Area.

From the standpoint of research into the development of railroad passenger service, this period constitutes a significant phase, for it was precisely at this time that the railroad companies were decisively losing out in local traffic competition — mainly to passenger automobiles. This provides a reason for dealing more closely with the changes that have taken place in the relationship between railroad passenger service and highway traffic as well as population factors.

3. THE RELATIONSHIP BETWEEN RAILROAD PASSENGER SERVICE AND SELECTED PHENOMENA

In 1934 there was a clear, positive correlation between frequency of train stops and population density, as estimated by counties. Population density plainly explained the areal variations in the frequency of stops.

Between the years 1934 and 1956, the situation changed (cf., Figs. 7 and 14). In 1956 the simple linear correlation between the densities of stops and population was: $r = + 0.35$, which is statistically significant at the 1.0 per cent level. The explained variation is only about 12 per cent of the total. This fits in well with the previously established fact that the passenger services of the railroads were modified to handled long-distance traffic in the main. Similarly, no kind of correlation can be perceived if the relative decrease in stops between 1934 and 1956 (Fig. 13) is compared with a map presenting the residuals from the regression between stop density and population density in 1934 (Fig. 8). In other words, the number of stops has not increased or decreased according to what one might have expected on the basis of the residuals if the density of population had been the determining factor.

Viewed at the county level, at the same time as the volume of passenger traffic on the railroads became ever more independent of the population density, the highway traffic began to correspond ever more

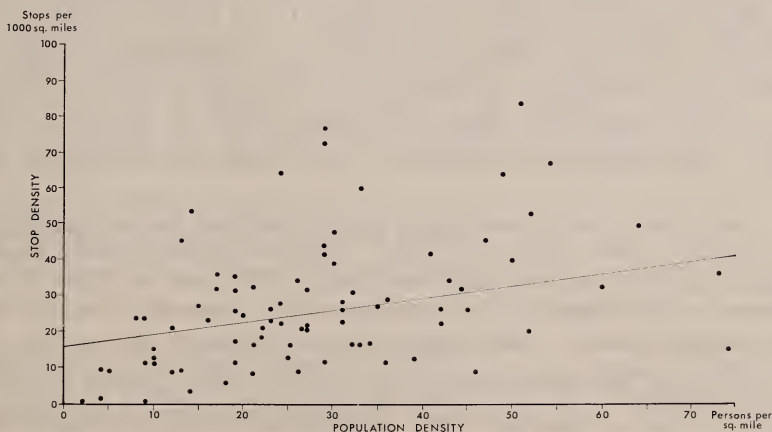


Fig. 14. Relationship between passenger train stop density (1956) and population density (1950) by counties in Minnesota.

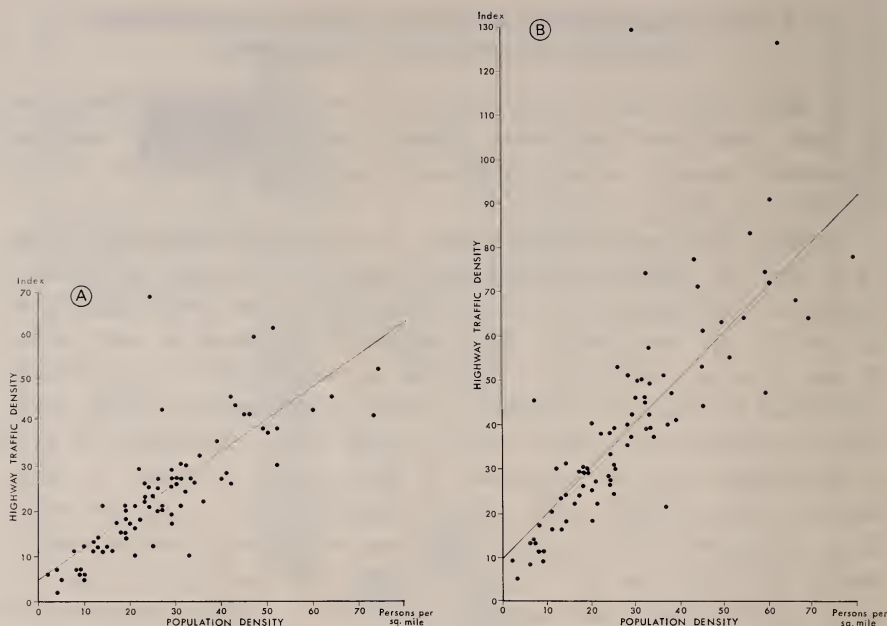


Fig. 15. Relationship between highway traffic density and population density by counties in Minnesota, 1950 (A) and 1960 (B).

closely to the distribution of the population. Fig. 15 presents the correlation between highway traffic density¹ and population density by the various counties in the years 1950 (A) and 1960 (B). The positive correlation between these two factors is exceedingly strong. The coefficient of correlation in 1950 was $+0.81$ and in 1960 $+0.78$. The slope of the regression line rises from $+0.69$ in 1950 to $+1.04$ in 1960. This shows the growth in the volume of traffic per capita.

¹ The highway traffic density index has been obtained for the counties directly from Borchert's (1963, Table A-1) study. The State Highway Traffic Flow Maps for the years 1950 and 1960 have been used as the point of departure for the calculation of the index. The traffic density index is actually a ratio of vehicle-miles per unit area, for each county, for an average 24-hour period, on the state highway system (*op. cit.*, pp. 16–17). Freight traffic has thus been included in the calculation of the index, and for this reason it serves as only a rough measure as far as passenger traffic is concerned. More serviceable for this purpose would, of course, have been data on, for example, the numbers of passenger cars; but unfortunately such information is not available for small areas.

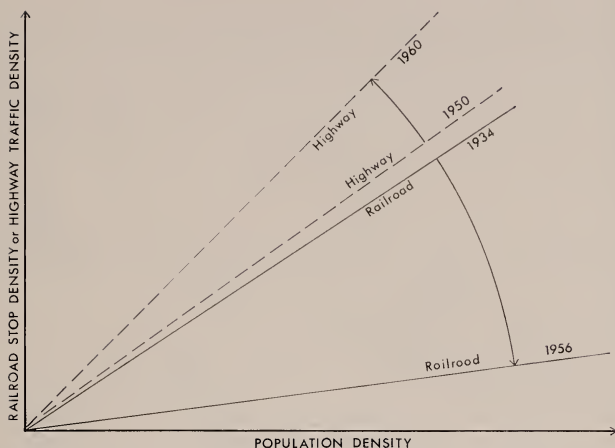


Fig. 16. Changing relationship between passenger train stop density, highway traffic density and population density. See text.

The changes occurring in railroad passenger traffic and highway traffic in relation to the distribution of population may be rendered graphically by drawing the regression lines presented in the previous diagrams (Figs. 7, 14 and 15) onto the same diagram (Fig. 16). In the diagram, the y-axis contains the density of railroad train stops and the density of highway traffic, while the x-axis contains the population density. An unbroken line represents the trend of the correlation between railroad traffic density and population density in the years 1934 and 1956. We note a conspicuous decrease in the regression coefficient. The regression line between highway traffic and population density, on the other hand, has turned in the opposite direction. The changes occurring in the regression coefficients measure the change in the significance of these types of traffic as calculated per capita. This diagram raises the question as to the relationship between railroad passenger service and highway traffic.

In the foregoing it was already noted that between population density and the density of train stops on railroads there was no longer any strong correlation in the year 1956. On the other hand, a singularly strong, linear, positive correlation appeared between highway traffic and population density. From this very circumstance it may be concluded that there cannot exist any very strong correlation between railroad passenger service and highway traffic. This is veri-

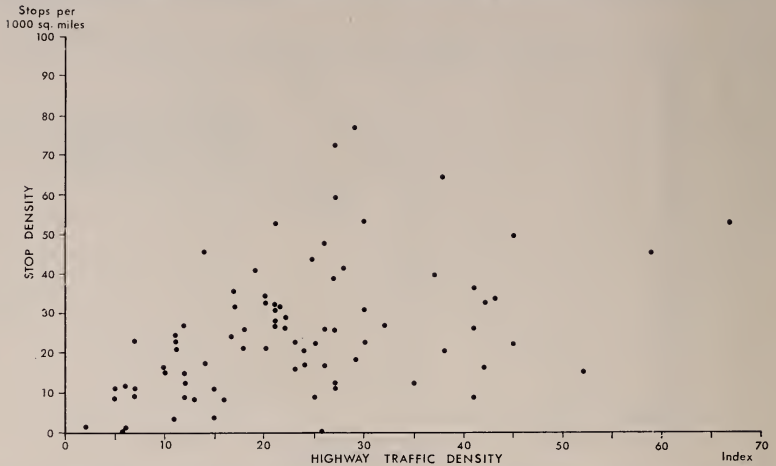


Fig. 17. Relationship between passenger train stop density (1956) and highway traffic density (1950) by counties in Minnesota.

fied by the diagram (Fig. 17), in which the y-axis contains the density of train stops in 1956 and the x-axis the density of highway traffic in 1950. Since the dispersion of the counties with respect to these two factors is quite considerable, it is possible that the material contains regionally diversified populations. In other words, the hypothesis may be advanced that the changes occurring in the railroad passenger traffic and their relation to automobile traffic have not taken place simultaneously throughout the state.

Figure 13 may be regarded as the point of departure for the verification of this hypothesis; on it are marked the percentage changes in train stops by counties. On the basis of this map, the state may be divided roughly into three parts (Fig. 18). The southern part clearly forms a separate entity. On the other hand, drawing a boundary between the central and northern parts is quite an arbitrary matter — but a necessary one from the standpoint of this operation. Within the framework of this tripartition, one might now re-examine the relations between the density of train stops in the railroad passenger services and the density of the highway traffic.

Figure 18 shows that there are differences between the various sub-areas with respect to the relation between highway traffic and the density of train stops, these differences being evident, for example, in the direction of the regression lines and the magnitude

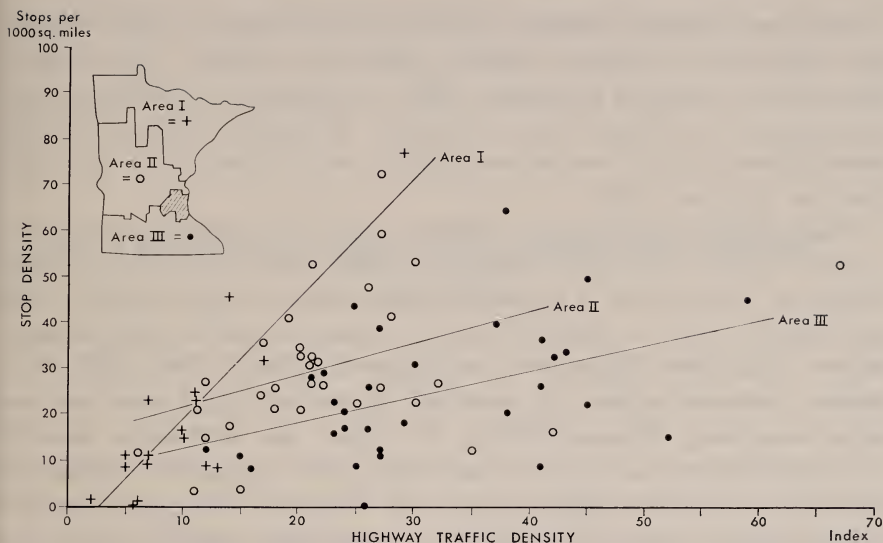


Fig. 18. Relationship between passenger train stop density (1956) and highway traffic density (1950) by counties in northern (Area I), central (Area II) and southern (Area III) Minnesota.

of the dispersion of points. I. The regression coefficient for northern Minnesota is the largest ($+ 2.61$) and the dispersion of points the smallest ($r = + 0.85$). II. The regression coefficient for central Minnesota is smaller ($+ 0.66$) and the dispersion much greater ($r = + 0.47$). III. In southern Minnesota the regression coefficient is the smallest ($+ 0.56$) and the dispersion of points approximately of the same order as in the central parts of the state ($r = + 0.44$).

In the light of the diagram, it would seem as if the density of passenger train stops in the northern parts of Minnesota had been relatively greater compared to the density of highway traffic than in the central and southern parts of the state. In other words, this examination supports the hypothesis presented earlier that the different sections of the state are, in a sense, at different stages of development. It is necessary, however, to approach this conclusion cautiously. Certain possibilities of error are contained in the source material, for passenger statistics are not available that might more accurately reflect the relations between railroad and highway passenger traffic.

The same sort of cautiously formulated result was obtained in the investigation where the number of train stops per inhabitant was used

to measure railroad passenger traffic and the highway traffic density per inhabitant to measure highway traffic by counties. The relative importance of railroad passenger traffic as compared to highway traffic was greater in northern than in southern Minnesota, although in both areas highway traffic was numerically far more important in the 1950's than the railroad traffic.

These differences between different parts of the state with respect to the relation between the density of train stops and highway traffic volume as well as the changes in the numbers of stops between 1934 and 1956 (Fig. 13) can also be linked to various population and economic factors. Southern Minnesota, including the Twin Cities and their vicinity, belongs in part to America's great industrial zone and so-called core area (Ullman 1957, p. 7). Here the increase in number of manufacturing jobs has in recent years been greatest in Minnesota (Borchert and Adams 1964, p. 3). In southern Minnesota, too, the average income level of the farms is appreciably higher than in the rest of the state (Nelson 1960, p. 73; Borchert and Adams 1964, p. 4). What this means is that the railroad passenger services first began to undergo a steep decline in the most populous and economically most advanced area of Minnesota.

4. THE PROFITABILITY OF RAILROAD PASSENGER TRAFFIC IN 1956

In spite of the fact that in the period 1934—1956 many unprofitable trains were taken out of service, passenger traffic brought ever heavier financial losses as the years passed. In 1956 the total railroad operating revenues of the thirteen companies (Class I) active in Minnesota amounted to \$273.1 million, out of which \$19.2 million were derived from passenger and allied services (\$7.9 million from passenger revenues, the rest from mail and express services, etc.) and \$253.9 million from freight and allied services. At the same time as the railroads in Minnesota gained a net profit of \$37.4 million in 1956 from freight and allied services, passenger and allied services operated at a \$22.5 million deficit, thus leaving the railroads with a \$14.9 million profit (State of Minnesota, Railroad and Warehouse Commission 1956).

Obviously, private railroad companies cannot for long keep unprofitable trains in operation. The financial losses sustained by the railroad passenger services in 1956 foreshadowed further curtailments.

IV. CHANGES IN RAILROAD PASSENGER TRAFFIC, 1956—1966

By 1966 the number of passengers traveling by train in Minnesota had decreased to 1.7 million, having been 2.6 million ten years earlier (Fig. 4). Although the number of passengers was cut by as much as nearly a million, the changes that had occurred in the areal structure of passenger traffic were even more notable. Service was discontinued by a total of 102 passenger trains, including mixed freight and passenger trains (State of Minnesota, Railroad and Warehouse Commission, unpublished data). This is a substantially higher figure than, for instance, that registered for the immediate postwar period, 1947—1956, when the number of passengers declined by 1.4 million but only 32 passenger trains were taken out of service (State of Minnesota, Railroad and Warehouse Commission, 1947—1956). This development was greatly affected by the Transportation Act of 1958.

It has previously been mentioned that the Transportation Act of 1958 facilitated the discontinuance by the railroad companies of unprofitable passenger trains. Before this, the companies had to submit their discontinuation decisions to the Minnesota State Railroad Commission for ratification. The commission in quite a few cases rejected such applications, inasmuch as local interests in the areas concerned were in conflict with the discontinuation plans. Following passage of the Transportation Act of 1958, jurisdiction over petitions was transferred to the Interstate Commerce Commission. On the part of Minnesota, the amendment of the law meant in practice making the discontinuance of interstate train services easier (cf., Kaups and Rikkinen 1968). As far as certain other states were concerned, the legislative amendment did not mean much, for there the juridical process permitting companies to abandon their services was less complex.

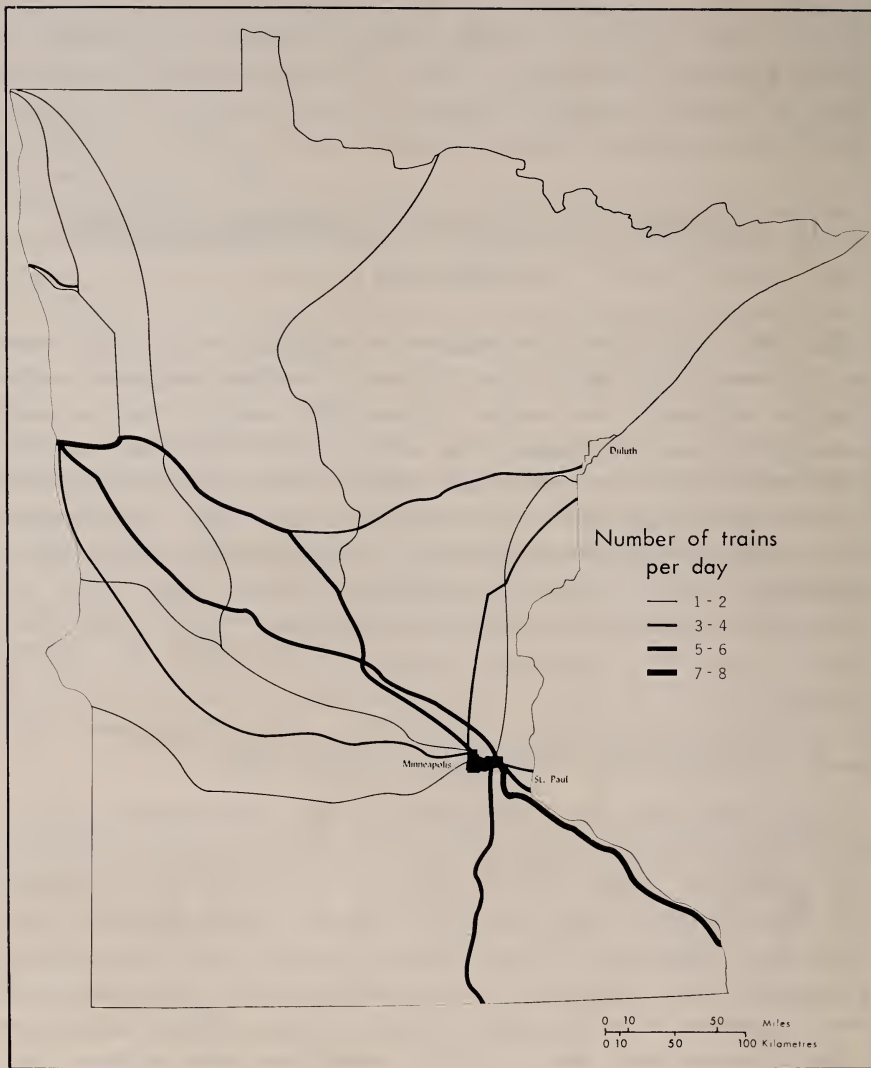


Fig. 19. Number of passenger trains daily in Minnesota, 1966.

1. CHANGES IN NUMBER OF TRAINS

The changes in train schedules between 1956 and 1966 can be noted by comparing the maps (Figs. 9, 19 and 20). The following observations may be made concerning the different types of lines:

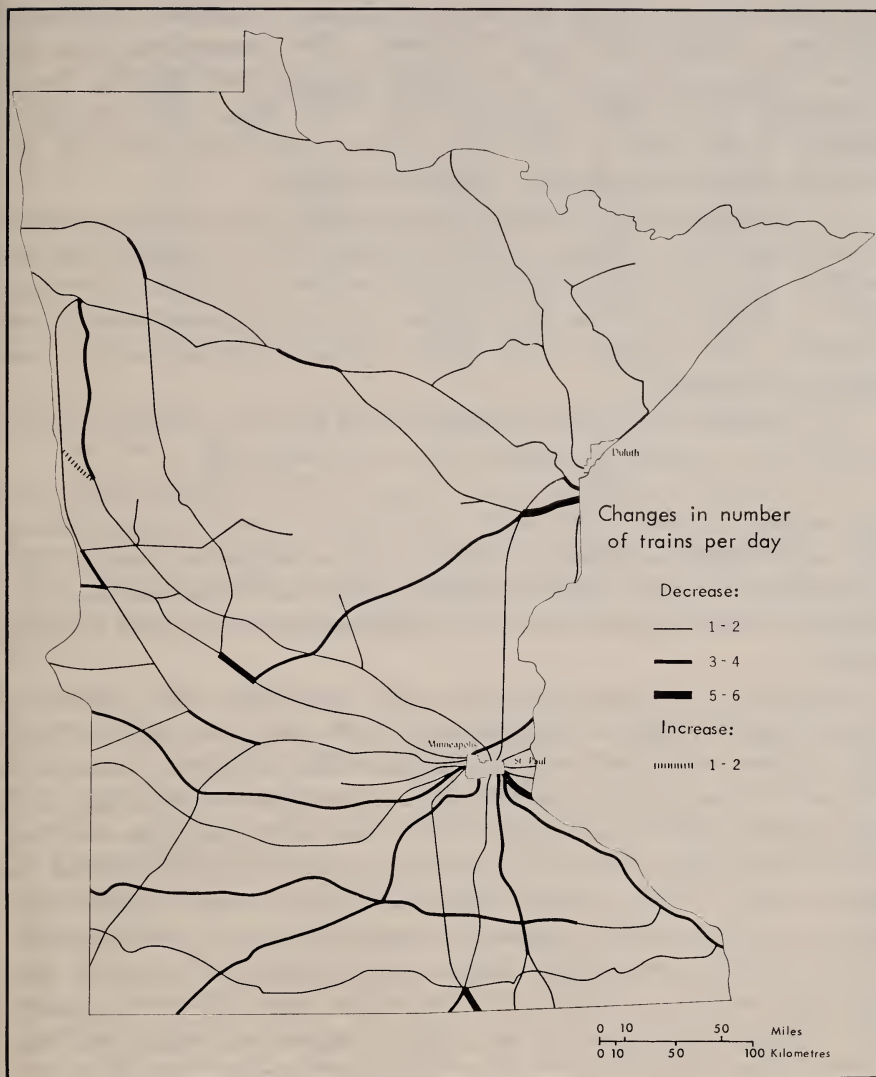


Fig. 20. Changes in number of trains a day in Minnesota, 1956—1966.

1) The long-distance lines retained their importance. Good connections are still maintained between Chicago, the Twin Cities and the Pacific coast. The main tracks, which run parallel across Minnesota in a southeast-northwest direction and have more than five trains

scheduled daily, belong to the two biggest competing companies (Northern Pacific and Great Northern). The connections from the Twin Cities to points south (St. Louis, Kansas City) are also firmly maintained (5—6 trains operating daily). On these main tracks, an average of only one or two trains a day were eliminated from the schedule during the ten-year period in question.

2) The most drastic reductions were made on the medium-distance connecting tracks, a large number of which were in operation as late as 1956. Of the tracks included in this category, only the connections between Duluth and the Twin Cities and the transcontinental lines remained. On nearly all the other routes, passenger service was abandoned entirely.

3) The few short local and branch tracks that were still in operation in 1956 were completely removed from the schedules.

4) The direct connection from Duluth to the Canadian border was discontinued, but the other daily runs back and forth between Minnesota and Canada continued to stay on the schedules as late as 1966. In practice, this was done by having a few cars detached from the Chicago—Pacific express trains or joined together to proceed on these tracks.

Generally considered, therefore, the trend that had previously started toward concentrating passenger traffic more and more on long-distance lines continued between the years 1956 and 1966. Whereas in the period between 1934 and 1956, the curtailment of passenger train schedules had affected local and branch lines most, it was the medium-distance connecting lines that in the last ten-year period suffered the biggest cuts. The railroad companies that did not control long-distance lines extending across the areas of several states and connecting major metropolitan centers were obliged to abandon their passenger business entirely. In 1966 there were only six companies still carrying passengers in the state of Minnesota, while ten years earlier their number had been as high as thirteen.

2. CHANGES IN NUMBER OF STOPS

In 1966 there were only 169 stations left in Minnesota that offered passenger services (Table 3). This figure is only 24.8 per cent of the corresponding figure ten years before. In the majority of cases (79.2 per cent), the service was the minimum possible, or one or two train

Table 3. Number of daily stops by passenger trains in Minnesota, 1966.

Number of stops	Stations	Per cent	Stops	Per cent
1—2	132	78.1	253	46.3
3—4	15	8.9	60	11.0
5—6	12	7.1	70	12.8
7—8	4	2.4	32	5.9
9—10	2	1.2	20	3.7
12	1	0.6	12	2.2
20	1	0.6	20	3.7
40	2	1.2	80	14.6
Total	169	100.0	547	100.0
Per cent of 1934	15.8		14.2	
Per cent of 1956	24.8		26.5	

stops daily. Also in the total number of stops a strong decline had taken place. In 1966 the Twin Cities accounted for 14.6 per cent of all train stops, which is markedly higher a proportion than in previous years.

Areally, the majority of the small stations are located along the routes leading to Canada as well as along the tracks running between Duluth and the Twin Cities (Fig. 21). On the other hand, on the more important long-distance routes, which carry the greatest number of trains, stops are generally made only at a few large stations. Fig. 22 shows that of the stations abandoned between 1956 and 1966, a prominent number was situated along these more important long-distance lines. As an illuminating example of this endeavor on the part of the railroad companies to speed up their long-distance traffic, mention might be made of the line owned by the Milwaukee Road on which the express train leaving the Twin Cities makes its first stop at Montevideo — that is, 133 miles (213 km) away. Ten years before there had still been as many as 21 stops between these cities.

At the time consideration was given to the changes that occurred in railroad passenger service in 1934—1956 attention was drawn to the relation between the railroads, highways and distribution of population by counties. In recent years, when the railroad passenger traffic in Minnesota has been concentrated almost exclusively in the long-distance services — on lines connecting major metropolitan centers

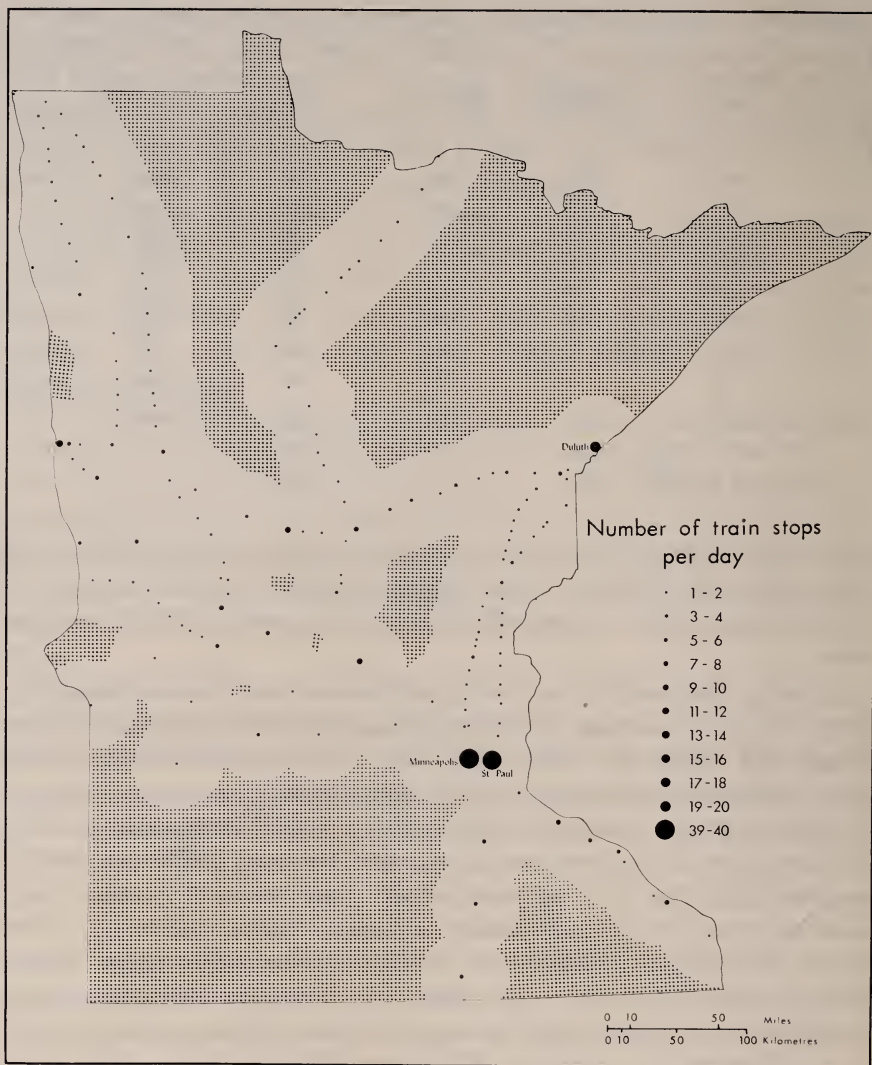


Fig. 21. Number of passenger train stops daily in Minnesota, 1966. In shaded areas, distance to nearest station is over 20 miles.

—, differences between minor territorial divisions within the state are no longer very significant. One reflection of the previously observed correlation between the railroad passenger traffic, distribution of population and level of economic development may be considered to be

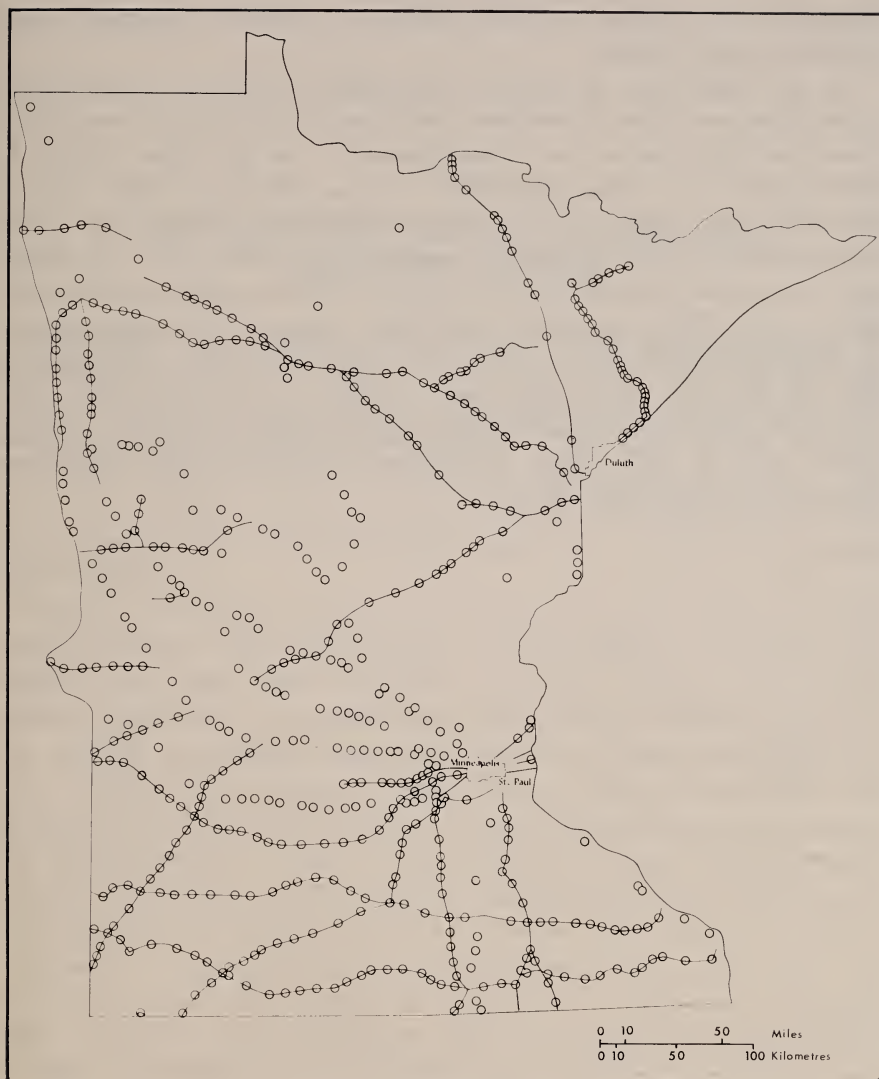


Fig. 22. Abandoned passenger train services and stations in Minnesota, 1956—1966.

the differences between southern and northern Minnesota. Densely settled southern Minnesota, where railroad passenger traffic before World War II was liveliest of all, is now nearly totally lacking in passenger train service. By contrast, the passenger trains still in

operation in the sparsely settled districts of northern Minnesota stop at nearly every station.

At the same time as railroad passenger service has concentrated on long-distance runs, it has been confronted by a serious competitive threat in the form of air transportation. On the other hand, in recent years the average passenger run has grown in length until it approaches the length of the average freight run. Thus, it is quite natural that the main channels of passenger rail traffic (Fig. 19) should also be the main lines of freight transport (Ullman 1949, pp. 244—245, 1957, p. 3). These important tracks are the ones that were among the first to be built in the last century (Brown 1949, p. 343; Meeks 1949, pp. 22—37). There has been a return to the beginnings. The number of railroad passengers in Minnesota in 1966 equalled the number carried back in 1879 (State of Minnesota, Railroad and Warehouse Commission, unpublished data).

V. PHASES IN THE DECLINE OF RAILROAD PASSENGER SERVICE

In summary, the regional development of railroad passenger traffic in Minnesota might be depicted by means of a descriptive model representing the different phases of development in cross-section. The basis of the diagram reproduced in Fig. 23 is a theoretical network of centers, which resembles Christaller's theoretical structure. The size of the circles denoting centers indicates their population, while the number of lines connecting them shows the number of passenger traffic routes.

Phase I. The first phase characterizes the time when railroad passenger service still was important. The network of railroads and stations is so dense that the distance from any point to the nearest railroad station does not exceed the average distance between stations. The number of passenger trains and, above all, the number of train stops (number of passengers) are in strong positive correlation with the population of the central places. All the railroads carry passengers. The average length of trips by train is short. Since the differences between small areas within the state greatly affect the distribution of the traffic, this stage might also be termed the »intrastate phase».

Phase II. Nearly all the short branch and side tracks have had their traffic either discontinued or reduced to a minimum. Passenger traffic in these sectors has shifted over to private cars. The number of trains operating on medium-distance connecting lines has been cut down; some of them have been changed to mixed passenger and freight trains. The number of long-distance express trains has remained the same and the traffic between the two largest centers (A and B) has even grown. In order to improve the competitive position of the long-distance trains, in particular, their speed has been increased by technical innovations, by shortening the routes as far as possible (C—D), and by shutting down some small station along the way (E).

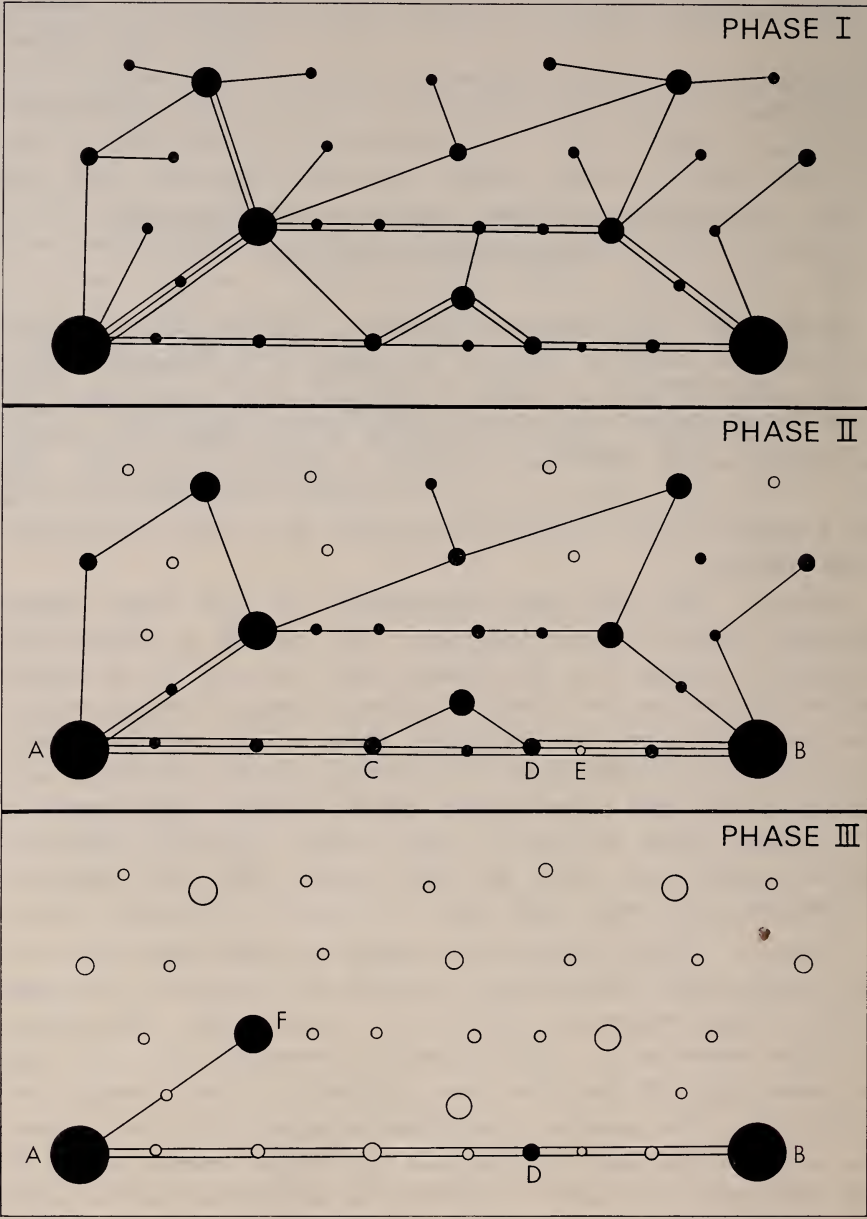


Fig. 23. Model of the phases in the decline of railroad passenger traffic in Minnesota. See text.

Phase III. Now in progress in the area selected for the present study, the state of Minnesota, this phase in the evolution of traffic is quite a simple one. The big cities (A and B) are connected by very fast express trains. This main line is joined by a side route, which links one rather large city (F) with the principal traffic channel. Thus, the medium-distance connections featuring the preceding phase have been abandoned. Similarly, the small centers situated along the main line, with a certain exception (D), have been left without passenger service. Taken as a whole, the railroad passenger service uses only a very small part of the potential capacity it could have at its disposal as far as tracks and stations are concerned. This stage might also be termed the »interstate phase», for the passenger traffic is determined primarily on the basis of the location of metropolitan centers beyond the state boundaries.

As the last phase, we might, of course, consider a situation where even the long-distance trains would have lost their importance. Such an eventuality might be expected in the light of the diagram presented in the beginning (Fig. 3), which illustrates the explosively rapid growth of air transportation in recent years. Railroad trains, on the other hand, will preserve their significance as commuter carriers in great cities like New York and Chicago, where all the people on the go just simply cannot be accommodated on the streets and highways if they tried to travel to and from the center on their jobs by car.

The descriptive model presented in the foregoing should be viewed as illustrating a continuous process, which develops at varying rates, depending on the area in question. The present study supports the assumption that the strong decline in railroad passenger service starts first in densely populated and economically more advanced areas. It is of great interest to compare this hypothesis with the results given in Ginsburg's (1961, pp. 110—119) »Atlas of Economic Development». In the factor-analytical study cited, railroad density proved to be an important measure of the economic development of the different states (cf., Haggett 1966, pp. 75—79). It would now appear as if the degree of decline in railroad passenger traffic could be used as the same sort of indicator with respect to the economically most advanced countries. Clear signs are to be seen that the trend also in those countries where the railroads are owned and managed by the state follows the main principles brought out in this study (e.g., Patmore 1965, pp. 71—81;

Godlund 1966, pp. 188—192). The decisions made in these countries are apt, however, to be influenced to such an extent by social and political factors operating behind the scenes that the decline of passenger service on the railroads might become characterized by features deviating in detail from the line of development undergone in the United States of America.

REFERENCES

- Alexander, John W., Brown, Earl S. and Dahlberg, Richard E. (1958). Freight rates: selected aspects of uniform and nodal regions. *Economic Geography* 34, 1—18.
- Borchert, John R. (1963). *Projection of population and highway in Minnesota*. Mimeo. Departments of Agricultural Economics and Geography, University of Minnesota. 53 p. Minneapolis.
- Borchert, John R. and Adams, Russell B. (1964). Projected urban growth in the Upper Midwest: 1960—1975. *Upper Midwest Economic Study, Urban Report* 8, I—V, 1—36.
- Broek, Jan O. M. (1965). *Geography: its scope and spirit*. 116 p. Columbus (Ohio).
- Brown, Ralph H. (1948). *Historical geography of the United States*. 593 p. New York.
- Christensen, D. E. (1966). The auto in America's landscape and way of life. *Geography* 51, 339—348.
- Ginsburg, Norton (1961). Atlas of economic development. *Department of Geography, University of Chicago, Research Paper* 68, V—VII, 1—119.
- Godlund, Sven (1966). Trafikutveckling och trafikinvesteringar. Summary: Traffic development and traffic investments in Sweden. *Meddelanden från Göteborgs Universitets Geografiska Institutioner* 83, 1—217.
- Haggett, Peter (1966). *Locational analysis in human geography*. V—Xii, 1—339 p. London.
- , — (1967). Network models in geography. *Models in geography*, ed. Chorley, Richard J. and Haggett, Peter, London, 609—668.
- Harvey, D. (1967). Models of the evolution of spatial patterns in human geography. *Models in geography*, ed. Chorley, Richard J. and Haggett, Peter, London, 549—608.
- Kaups, Matti and Rikkinen, Kalevi (1968). Some geographical implications of passenger train service curtailment and abandonment in Minnesota, 1920—1966. *Journal of the Minnesota Academie of Science* 35, forthcoming.
- Meeks, Harold A. (1959). Railroad expansion and agricultural settlement in Minnesota, 1860—1910. *Proceedings of the Minnesota Academy of Science* 27, 22—37.
- National atlas of the United States (1950). *Major land uses in the United States*. Washington D.C.
- Neft, David (1959). Some aspect of rail commuting: New York, London and Paris. *Geographical Review* 49, 151—163.

- Nelson, Lowry (1960). *The Minnesota community: country and town in transition*. V—VII, 1—175 p. Minneapolis.
- Patmore, J. Allan (1965). The British railway network in the Beeching era. *Economic Geography* 41, 71—81.
- Robinson, Arthur H. (1956). The necessity of weighting values in correlation analysis of areal data. *Annals of the Association of American Geographers* 46, 233—236.
- Robinson, Arthur H., Lindberg, James B. and Brinkman, Leonard W. (1961). A correlation and regression analysis applied to rural farm population densities in the Great Plains. *Annals of the Association of American Geographers* 50, 211—221.
- State of Minnesota, Railroad and Warehouse Commission (1917—1956). *Annual and biannual reports*. St. Paul.
- Stover, John F. (1961). *American railroads*. Chicago.
- Thomas, Edwin N. (1930). Maps of residuals from regression: their characteristics and uses in geographic research. *State University of Iowa, Department of Geography, Publication 2*, 1—58.
- Ullman, Edward L. (1949). The railroad pattern of the United States. *Geographical Review* 39, 242—256.
- * — (1958). *American commodity flow: a geographic interpretation of rail and water traffic based on principles of spatial interchange*. V—XXII, 1—215 p. Seattle.
- U. S. Bureau of the Census (1960). *Historical statistics of the United States, colonial times to 1957*. Washington D.C.
- * — (1965). *Historical statistics of the United States, colonial times to 1957; continuation to 1962 and revisions*. Washington D.C.
- * — (1936). *Statistical abstract of the United States*. Washington D.C.
- * — (1967). *Statistical abstract of the United States*. Washington D.C.
- Wallace, William H. (1958). Railroad traffic densities and patterns. *Annals of the Association of American Geographers* 48, 352—374.
- * — (1933). Freight traffic functions of Anglo-American railroads. *Annals of the Association of American Geographers* 53, 312—331.
- * — (1935). The bridge line: a distinctive type of Anglo-American railroad. *Economic Geography* 41, 1—38.
- Walmsley, Mildred M. (1965). The bygone electric interurban railway system. *Professional Geographer* 17: 3, 1—6.
- Wolfe, Roy I. (1962). Transportation and politics: the example of Canada. *Annals of the Association of American Geographers* 52, 176—190.

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**POPULATION CHANGES IN THE
INCORPORATED HAMLETS
OF MINNESOTA, 1930-1960**

BY
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Presented the 17th of May 1968 by
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ABSTRACT

The study analyzes the population trends in the incorporated hamlets of Minnesota in relation to that of their surroundings by ten-year periods, 1930—1960. As a quantitative tool, a graphic and cartographic technique has been devised.

In most cases the hamlets, though on the average they steadily declined in population, have remained more positive than their surroundings with respect to population change. In detail the developments are characterized by great diversity and vary spatially and temporally.

In the 1930's the majority of the hamlets were still growing. Moreover, the population growth of the majority of the hamlets was substantially more rapid than that of the townships surrounding them. The exception is the northeastern forested region. In the 1940's and 1950's there took place a marked decline in the population trends of both hamlets and surroundings. During these decades distance to the nearest city became a factor that increasingly influenced the population trends. In the three decades which have been used in this study, there has been a gradual decline in the differences in population trends between the hamlets and their surroundings.

1. INTRODUCTION

The rural settlement of Minnesota is primarily of the »pure isolated farm type» (Zimmerman 1930, pp. 3—5), which means that each farmhouse is located on its individual plot of land. The trading and administrative functions are usually separately located in urban agglomerations.

At the turn of the century, crossroads stores appeared as the first sign of the emergence of non-agricultural activities and formed the nucleus for the first and most elementary type of trade center (*op. cit.*, p. 9). The next largest centers were the many hamlets and villages. Most of the farms in Minnesota were within an hour's distance of one or more of these types of centers by means of the transportation available in those days. The village and the open country around it interacted very closely; and this, by modern standards, narrow sphere of activity enclosed the community in which the majority of

people lived most of their lives (cf., Fuguitt 1963, p. 247). But the great economic, technological and social changes that have taken place during the present century have radically altered the relationship between village and country. Above all, the increase in the mobility of the population and the improvement in the economic welfare of the farmers have broken down the old isolation of the traditional rural community.

The first sign of the increased mobility of the rural population to appear in the urban settlement fabric may be the gradual disappearance of the crossroads stores. Zimmerman (1930, p. 42) noted this development in studying the farm trade centers of Minnesota during the period 1905—1930. With the advent of the motorcar, people living in rural areas no longer had to trade at rural stores. Stores in small villages attracted more people, and between 1905 and 1930, these communities showed remarkable vitality (*op. cit.*, p. 42). The populations of villages with less than 2,500 inhabitants remained unchanged on the average in Minnesota during this period (Lively 1932, pp. 4—9).

In the 1930's the significance of the villages also began to diminish, parallel with the process of depopulation. The decline at first applied only to the very smallest villages. During the decade 1930—1940 the majority of the villages in the United States with less than 2,500 inhabitants underwent no change in population. On the other hand, 52 % of the villages with a population under 250 decreased in size (Ratcliffe 1942, p. 322; cf., also deS. Brunner and Smith 1944, pp. 107—108). The same trend continued during the next decade, when 64.5 % of the small villages throughout the country (excluding hamlets in suburban counties) decreased in population. The population trend in the larger villages, too, was less favorable than during the preceding decade (deS. Brunner 1952, pp. 127—131). The trend has continued to be the same later on as well (cf., e.g., Northam 1963, p. 54; Hart and Salisbury 1965, pp. 140—160). Nevertheless, the body of literature on the subject »shows a lack of general agreement about whether trade centers actually are declining and, if so, to what extent» (Hodge 1965, p. 89).

Barring a few exceptions (including Hassinger 1956; Salisbury and Rushton 1963; Rikkinen 1968 b), the majority of studies dealing with population trends in villages have the common feature that the developmental process has been examined in terms of statistical units as such without paying any attention to how the trend of population in the village is related to the general regional trend and, especially, that

of the immediate sphere of influence. This must nevertheless be taken into account when the causal relations affecting the population development of villages are weighed, along with the question of the »death of small villages». Let us consider, for example, a case where the population of some village decreases during some ten-year period by 20 % but that of the surrounding countryside by 30 %. Although the population statistics for this village did indicate a fairly rapid rate of decline, nevertheless, in comparison with the population trend of its surroundings, the pattern of development for the village is relatively favorable. This mode of examining the situation at least introduces significant added information into the developmental picture.

The present study has a two-sided aim:

1) It seeks to elucidate the population trend in the smallest villages (= hamlets) of Minnesota between 1930 and 1960 by comparing it with the changes in population of the area surrounding the hamlet. The central objective of the study is thus to analyze the changes undergone by these hamlets specifically as places of residence.

2) It purposes to produce a simple technique of presentation and an analytical procedure whereby the population trends in the hamlets and their surroundings can be relevantly compared.

2. INCORPORATED HAMLETS

Minnesota is one of the »most incorporated» states in America because of its liberal laws governing the incorporation of areal divisions. According to the laws of Minnesota, 100 inhabitants suffice as the minimal population of an area for its incorporation (Nelson 1960, pp. 29, 108). The present study deals with all the incorporated villages of Minnesota that had less than 250 inhabitants during at least one year according to the census between 1930 and 1960. In line with certain earlier researchers (Ratcliffe 1942, p. 318; deS. Brunner 1952, pp. 130—131), the present author has decided to refer to these very small villages as *incorporated hamlets*.

The United States Census of Population provides source material for the study, for the data cover all the independent administrative communities, including the incorporated hamlets, ever since their establishment. The classification of hamlets has been also construed to include *urban places* of less than 250 inhabitants, even if unincorporated,

provided their population figures have been separately published. Excluded from the study, therefore, are the so-called *unincorporated hamlets* for which accurate population data are unavailable (Trewartha 1943, pp. 33—35, 1941, pp. 35—42).

Just why hamlets have been chosen as the subject of this study may be explained by the fact that they constitute the most elementary form of all the *incorporated urban places*, the designation applied in the U.S. Census. But even more important from the standpoint of the research method used is the fact that incorporated hamlets form a homogeneous category, in the frame of reference of which it is most expedient to observe the correlation between urban places and their surroundings with respect to the population trends. The advantage afforded by hamlets, as compared to larger villages, is revealed best by the circumstance that a fairly limited area — e.g., one the size of the traditional rural community — might be demarcated as the neighborhood of a hamlet. This means that the population changes in any locality are influenced by »external factors», such as the proximity of a city of substantial size, in very nearly the same way, at least as far as the factor of distance is concerned, at the different sides of the hamlet. The diversity of the factors affecting the development of population can thus, in a certain sense, be limited. And this is likely to facilitate the search for more general and consistent patterns of development. Accordingly, hamlets offer perhaps the most reliable starting point — from the standpoint of both research techniques and the observation of evolutionary processes in the traditional rural community — for the study of the patterns of population change in small centers and their environs.

3. RESEARCH METHOD

Edward Hassinger (1956) studied the small trade centers of forty-three southern Minnesota counties during the decade between 1940 and 1950. An examination was made of the relationship between population changes in incorporated places with less than 2,500 inhabitants and the percentile change in the population of each county exclusive of incorporated places. The correlation of $r = .30$ indicated that the relationship between these two variables was not large. Further, a test was made to determine whether trade center population changes

for county areas differed with regard to state economic areas. It was found by means of the analysis of variance technique that the mean per cent population change of incorporated places by counties was not significantly different for the four economic areas located in the study area (*op. cit.*, pp. 78—88). The county was thus used as the smallest areal unit in measuring the population development of the vicinity of a trade center.

When Salisbury and Rushton (1963) investigated the population changes in villages of less than 1,000 inhabitants in two sample areas in the state of Iowa, they used the pattern of development of a vicinity to illustrate substantially smaller areas. The population changes in villages between 1950 and 1960 were compared with population changes for the same period in the townships in which they were situated. Also after this study, the notion that dispersed rural population changes may account for the changes observed in villages is statistically not well supported (*op. cit.*, p. 57).

Also in a study dealing with the Duluth area, population changes taking place in villages and surrounding townships were compared in terms of ten-year periods, 1930—1960 (Rikkinen 1968 b). In this work, in which the material was handled largely by means of analysis based on diagrams, a clear correlation was noted between the villages and their environs at every period with respect to the pattern of population developments (*op. cit.*, Figs. 4, 7 and 10). The correlation is clearly discernible, however, only in the case of villages of about the same size and, even at that, only as far as communities situated at approximately the same distance from Duluth are concerned. In other words, the population changes in both villages and their surroundings are curvilinearly related to distance from some fair-sized city, and this relationship has varied from time to time on the part of each separately. In the light of this experience, an effort has been made in the present paper to clarify the population changes in incorporated hamlets and their surroundings primarily by means of graphic and cartographic methods of analysis.

In Minnesota there was a total of 271 hamlets with a population under 250 during at least one census year between 1930 and 1960. Statistical data offering a basis for making comparisons are not, however, available for them all. Some of the hamlets did not become incorporated until after 1930, while others are such that, because, for example, of areal consolidation for administrative purposes, population

figures for two different census years cannot be compared. It is for this reason that the number of hamlets included in the analysis varies from decade to decade.

The population change in the township surrounding each hamlet has been used to depict the developmental trend prevailing in the vicinity. In the majority of cases, the area of the vicinity is nearly 36 square miles, which is the »regular» size of a township. Where any hamlet happens to border on two or more townships, the average population change in these townships has been used. In the case of hamlets that are designated as »unincorporated urban places», the changes in the population of the vicinity have been obtained by subtracting the population of the hamlet from that of the township. In certain exceptional instances in northern Minnesota, figures useful for making comparisons have been obtained on the population changes in hamlets but not those in their surroundings. The communities in question are either extensive Indian reservations or unincorporated townships. Such cases have been omitted from the analysis.

The total number of villages analyzed in the different decades were as follows:

1930—1940	198
1940—1950	214
1950—1960	236

In comparing the population trends of the hamlets and their environs, the starting point in the present study consists of the percentual changes occurring in them from decade to decade. An attempt has been made to determine the correlation between these two variables by means of the scatter diagram shown in Fig. 1, where the changes in the population of the hamlets have been represented on the ordinate axis and those of the surrounding townships on the abscissa axis. At the point of intersection of the axes the changes in the population of both are nil.

By placing the hamlets on this scatter diagram, the material can be graphically examined from many points of view. First, the material can be examined separately from the vantage point of each variable. It is quite easy, for instance, to compare the relationship of the growing hamlets situated above the abscissa axis to the hamlets with a decreasing population.

The practical value of the diagram becomes further evident in comparing the correlation between the two variables. In order to

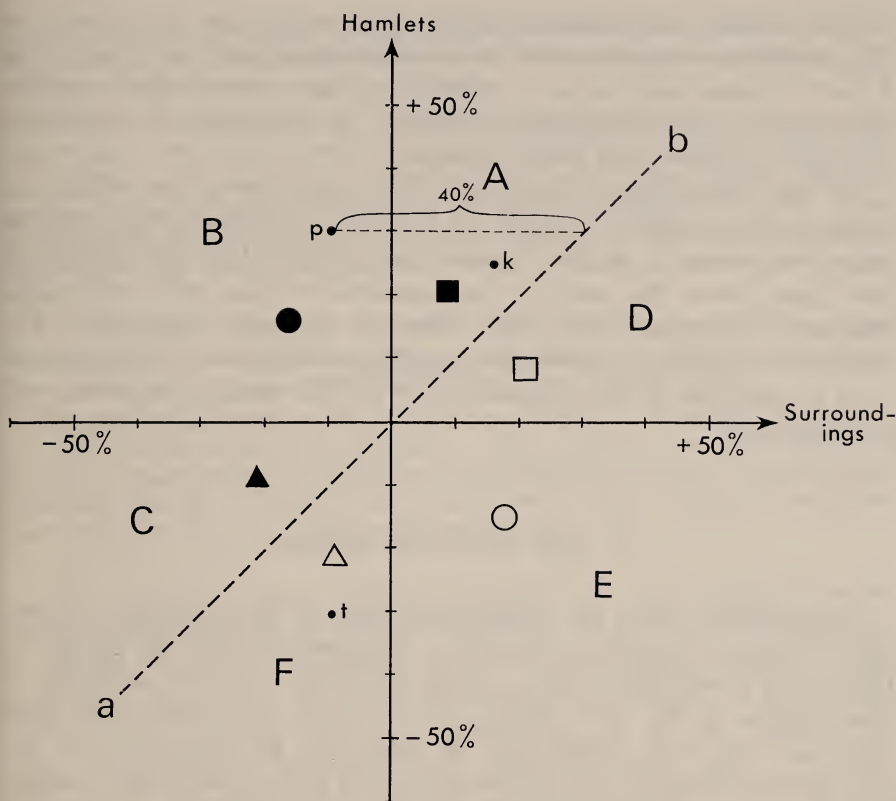


Fig. 1. The method for comparing the population changes in the hamlets and their surrounding townships. See text.

enhance the graphic character of the diagram, the line *a-b* has been drawn, dividing the material into two parts: at the points situated above the line, the change in the population of the hamlets has been more positive than that of the surrounding townships, whereas below it the population change in the hamlets has been negative in comparison to that in the surrounding area. Thus, for example point *k* in the diagram represents a case in which the population of both hamlet and township has grown, but that of the hamlet more. At point *p* the population of the hamlet has grown but that of the vicinity diminished. Point *t*, again, represents a case in which the populations of both hamlet and township have decreased but that of the latter relatively not so much as that of the hamlet — or, in other words, the population trend of the township may be regarded as more positive than that of the hamlet.

The ordinate and abscissa axes as well as the line *a-b* divide the diagram into six sectors, which have been marked with the letters from A to F. Inside each sector a symbol has been placed which will be later used in the cartographic analysis of the types of population changes in hamlets and their environs.

In the cartographic exposition, the magnitude of the difference between the population changes of hamlet and township can also be taken into account. In the diagram this is depicted by the distance of each point from the line *a-b* as measured in line with either the ordinate or abscissa axis. The difference is easily computed. For example, at point *p*, where the population change of the hamlet is + 30 % and that of the township — 10 %, the distance from line *a-b* is 40 per cent.

4. THE 1930—1940 PERIOD

In accordance with the method described in the foregoing, the pattern of hamlet population change in Minnesota during the decade of 1930—1940 is represented in the diagrams in Fig. 2 and the map, Fig. 3. Also marked in the latter figure are the towns with more than 5,000 inhabitants in 1940. Generally, in proportion to population, in the preponderantly agricultural western districts of Minnesota and sparsely settled northern areas there is the largest number of hamlets.

Population change in the hamlets has been approached through a regionalization. Regions have been drawn on the basis of the general grouping of the hamlets and the general natural, economic and urban-geographical factors likely to influence their population development. The state has been divided into seven regions, as follows:

I. This region comprises the forested northeastern part of Minnesota. The boundary of the region follows the uniform boundary zone between the forest area and the field area in the west and south (Borchert and Adams 1964, Fig. 4). This is the most sparsely settled part of the state. The population is concentrated mostly in Duluth and its vicinity as well as the Iron Range mining country. The region has been called the »Cutover» and referred to as the »rural problem area» of Minnesota (Nelson 1960, p. 126).

II. The northwestern part of Minnesota is farm country, the westernmost stretch being prairie land. With regard to the type of farming carried on there, it is a small grain and specialty crop area (Nelson 1960, p. 16; Knudtson and Cox 1962, p. 5).

III. This is a diversified dairying and general farming area (*op. cit.*). It does not belong in the regular prairie region, for the landscape is undulating. The central part of the area is hilly lake country.

IV. This area merges into the preceding area without any sharp line of demarcation. Dairying and potato growing are characteristic of the local agriculture.

V. The southwestern part of Minnesota is a fertile prairie, where agriculture is characterized by intensive production of corn and livestock (*op. cit.*). In the preponderantly agricultural regions III and V, there is the largest number of hamlets, although the population density is not so great as in the following two areas.

VI. The region comprises the present commuting range of the Twin Cities (Minneapolis, St. Paul) (Adams 1964, p. 44), where the population growth has been exceedingly vigorous during the period covered by this study.

VII. This area, which in the broadest sense belongs, along with Area V, to the great Manufacturing Belt of the U.S.A. (Ullman 1957, p. 7), is also characterized by rapid industrialization, urbanization and population growth in recent decades (Photiadis 1953, p. 7; Borchert and Adams 1953, p. 13). The local agriculture specialization is dairying and livestock raising (Nelson 1960, p. 16).

This regional division will be preserved also in the study of subsequent ten-year periods in order to facilitate the making of comparisons.

Of the hamlets in Minnesota, 71.2 % grew during the 1930's (Table 1, types A, B and D). However, the population changes in the hamlets varied very markedly in all the areas (Fig. 2), as was likewise the case in comparing the different states (Ratcliffe 1942, p. 322). Throughout most of Minnesota, the average population growth of the hamlets was 15 per cent. In the vicinity of the Twin Cities (VI), however, the

Table 1. Number of types of population change in the hamlets and their surrounding townships in Minnesota, 1930—1940. For explanations compare text and Figs. 1 and 3.

Type of population change	Difference in population change between hamlets and their surroundings (Per cent)				Total	
	0—9.9	10—19.9	20—29.9	>30	Number	Per cent
A	18	12	10	6	46	23.2
B	11	22	15	24	72	36.4
C	11			3	14	7.1
D	10	5	2	6	23	11.6
E	5	4	4	10	23	11.6
F	13	4	2	1	20	10.1
Total	Number	68	47	33	50	198
	Per cent	34.3	23.7	16.7	25.3	100.0

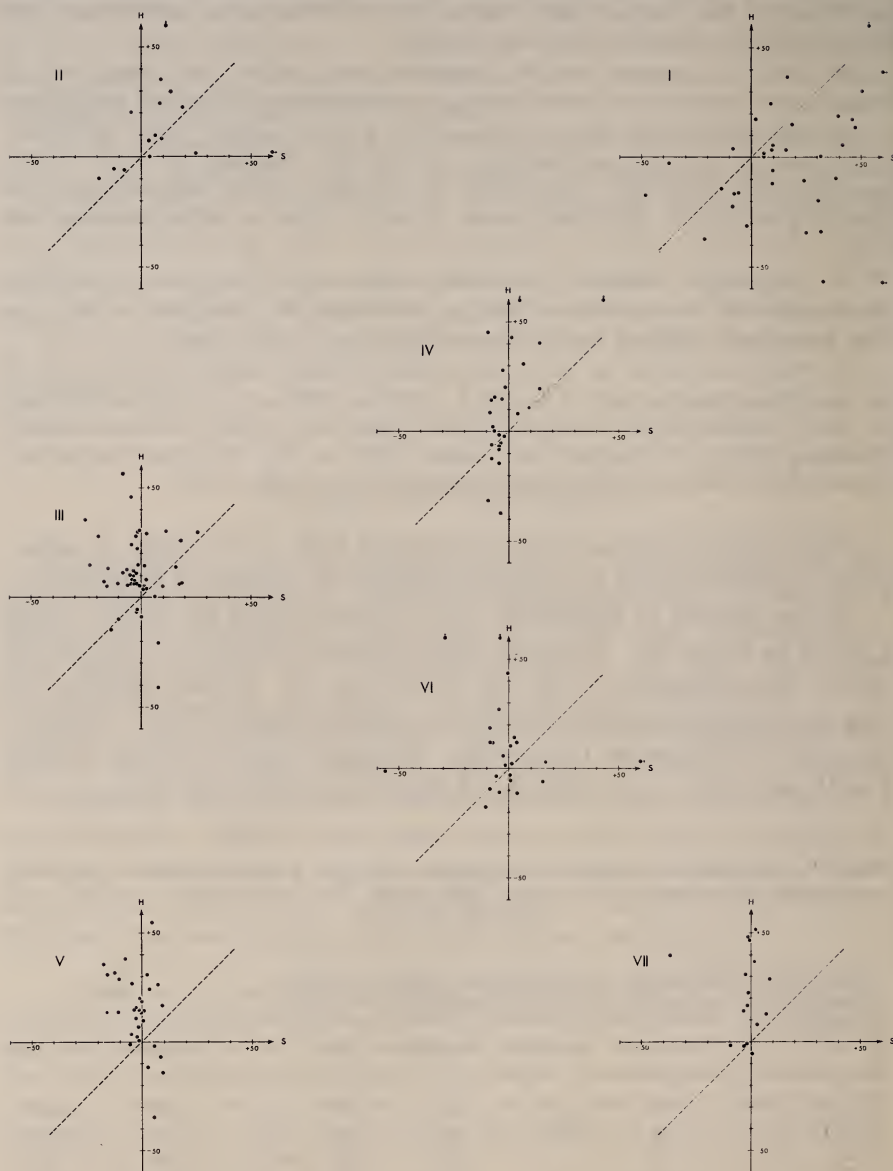


Fig. 2. Relationship between population changes in the hamlets (H) and their surrounding townships (S) by regions in Minnesota, 1930—1940. Regions I—VII the same as in Fig. 3.

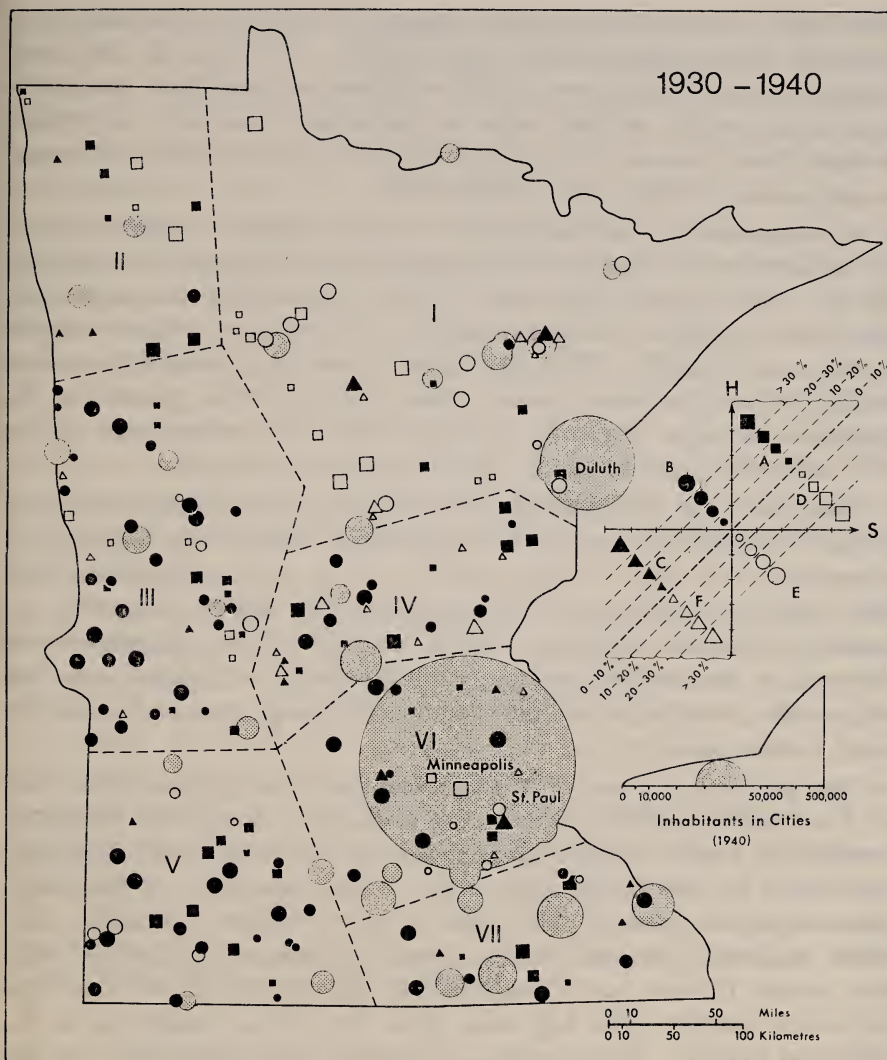


Fig. 3. Types of population change in the hamlets (H) and their surrounding townships (S) in Minnesota, 1930—1940. For legend compare text and Fig. 1.

average growth was smaller, whereas, deviating from the other areas, in the forested region (I) slightly more than one-half the hamlets underwent a decrease in population.

If the population trend of the vicinities of the hamlets is examined separately, it will be seen that in the southern parts of Minnesota

(IV—VII), the situation on the average has remained unchanged, the variation being comparatively slight (+ 10 — — 10 %). In the more northern areas (I—III), the spread representing population changes is considerably wider on both sides of the mean. In areas I—II, which deviated from the rest, the majority of the rural townships increased in size, some of them quite substantially.

A comparison of the hamlets with their vicinities reveals that in the greatest part of the state the population development of the hamlets was more positive than that of their surrounding townships (cf., also Table 1). This is demonstrated by the profusion of black symbols in the map (Fig. 3). The northeastern area (I), however, deviates distinctly from the other areas. Here the population growth of the hamlets was below the state average while, by contrast, that of the rural townships was distinctly above the state average.

Also near the metropolitan center of the Twin Cities, there is a group of hamlets in which the population change was negative in comparison with that of their environs. The same phenomenon was also noted for this period with regard to the larger villages in the vicinity of Duluth (Rikkinen 1968 b, Fig. 4). The population trend observed in the hamlets situated in the proximity of smaller cities did not, on the other hand, deviate significantly from that of hamlets located farther away.

The population trend of the hamlets and the regional differences in it reflect the general pattern of population change in Minnesota during this decade, which was marked by the exceptional conditions introduced by the Great Depression. The population of Minnesota grew during the period 1930—1940 by 8.9 % (1930: 2,563,953 inh.), which roughly corresponds to the natural increase of population during this decade (Nelson and Clappitt 1945, pp. 4—9). There was little migratory activity. The big cities grew, but not as rapidly as in the preceding decade. The population of Duluth even decreased. On the other hand, the trend of rural population showed quite a definite »back-to-the-land» tendency. The farm population grew particularly in the northeastern region, where there occurred a marked increase in the acreage of land under plow and in the number of farms. The number of farms increased in this region between 1930 and 1935 an average of 30 per cent (*op. cit.*, pp. 22—23). The area of cultivated land did not increase in the same proportion, which means that the tendency was toward cultivating fewer acres.

Since in the »Cutover» region population growth was primarily based on clearing new plowland, it is easy to understand the great variations shown in the diagram (Fig. 2), owing to the local natural conditions. The fact that there are many hamlets in this area whose population diminished quite appreciably can be traced to the effects of the Depression insofar as many of these communities were dependent on mining and lumbering jobs. The preceding decade was likewise characterized by great local variations in the population trend in the same area and for the same reason (Lively 1932, pp. 18—23). On the other hand, in more southern districts, where the farming population was of old stock and all the possible land had long before been cleared for cultivation, there was not much opportunity for the establishment of new farmsteads. Here the inhabitants tended to stay put, weathering bad times close to the primary sources of production. The Great Depression seemed to have the effect of obstructing the shift of population from farm to town and keeping the situation in the agrarian environs of hamlets stable.

Taken as a whole, many features of the so-called traditional rural community still survived in the 1930's. Owing to the economic slump and its effects, the mobility of the population did not increase at the same rate as in the preceding decade. People remained rooted insofar as possible. Small hamlets continued to be important residential areas. Although the number of business units did decrease somewhat in this decade in small centers (Nelson and Jacobson 1941, p. 101), it did not necessarily signify that hamlets were on the wane as places of residence. Furthermore, they continued to preserve their character as traffic magnets. Thus the hamlets, of which the majority were located alongside railroad tracks, remained important centers of railroad passenger traffic in the 1930's (Rikkinen 1968 a, Fig. 6).

5. THE 1940—1950 PERIOD

The pattern of population change in the hamlets and their environs in the 1940's differs strikingly from that of the preceding decade (cf., Figs. 2, 4 and 3, 5).

The population trend in the hamlets was on the average negative throughout the state of Minnesota during the decade of 1940—1950 in

Table 2. *Number of types of population change in the hamlets and their surrounding townships in Minnesota, 1940—1950. For explanations compare text, and Figs. 1 and 5.*

Type of population change	Difference in population change between hamlets and their surroundings (Per cent)				Total	
	0—9.9	10—19.9	20—29.9	>30	Number	Per cent
A	4	4	2	4	14	6.5
B	6	21	22	25	74	34.6
C	34	10	7		51	23.8
D	1	1	1	2	5	2.3
E		4	6	4	14	6.5
F	26	17	8	5	56	26.2
Total	Number	71	57	46	214	100.0
	Per cent	33.2	26.6	21.5	18.7	100.0

comparison with the preceding decade. More than half the hamlets (56.6 %) diminished in size (cf., Table 2). An especially conspicuous reversal in the developmental trend took place in the areas of intensive agriculture (III—V), where the population of the hamlets had undergone a steep rise in the 1930's but now declined appreciably. The decrease in population continued in the forest region (I). Only in the northwestern area (II) and the most highly industrialized areas (VI—VII) of Minnesota did the pattern of population change remain on the average approximately the same as it had been ten years before.

The same developmental tendency as characterized the hamlets could be observed in the townships surrounding them. Agriculture began to be transformed into large-scale, mechanized operations. The average decrease in the environs of the hamlets ranged between about 5 and 15 per cent. The greatest change in the trend took place in area I, where the agricultural population grew at the heaviest rate in 1930—1940. It has been fittingly remarked that this northern forested area »acts as a sponge, absorbing population in bad times, and releasing it in good times» (Nelson 1960, p. 24).

The majority of the hamlets (65.0 %) were of the kind where the population trend was more positive than that of their townships (Table 2). In this respect, therefore, no change occurred in comparison with the preceding decade. On the other hand, the numerical relations between the different types of population development did change. In 1940—1950 over half the hamlets fell into types C and F, or of the kind

characterized by a decrease in the populations of both hamlet and environs (1930—1940: 17.2 %; cf., Tables 1 and 2).

With regard to the areal distribution of the different types of population trends, the following observations may be made (cf., Figs. 3 and 5):

1) In the 1930's types D-F were mainly concentrated in the cutover area (I). In the 1940's hamlets with a negative population trend in comparison with their environs were fairly evenly spread throughout Minnesota.

2) Hamlets with a noticeably more positive population trend (over 30 %) than their environs were concentrated mostly in the proximity of large cities as well as in the zone running across the state from the Twin Cities northwestward along the main line of the Chicago-Pacific railroads (Rikkinen 1968 a, Fig. 5). The influence of the cities is exerted in varying ways on the population growth of the hamlets as the distance from them increases. Closest to the cities, types A and D, which elsewhere are rare, are a common occurrence. Farther from the cities, type B becomes common. Deviating from the preceding decade, also the smaller towns — in addition to the Twin Cities and Duluth — appear to have the effect of a suburbanizing phenomenon in the population trend of the hamlets and their environs.

3) Outside the commuting range of the big cities, there are hamlets in the western parts of the forested area (I) and area II that have grown vigorously in comparison with their vicinities. This is to be partly understood as an effect carrying over from the 1930's: these areas experienced the largest expansion of plowed land of any in the state. With mechanization this resulted in a substantial surplus agricultural population. The net loss of rural inhabitants through migration was the heaviest in 1940—1950 in these very localities (Ramsey, Orman and Nelson 1954, p. 8). Accordingly, the exceptionally positive population trend in certain hamlets in comparison with their environs can be explained through the decrease in the agricultural population. On the other hand, matters are probably affected by the special character of the settlement of these northern regions. Where large towns are lacking, it is conceivable that small »isolated» hamlets may preserve their importance better than those in southern regions both as service centers and as places of residence.

4) In the densely settled and preponderantly agricultural region V, the population changes in the hamlets and their environs were very

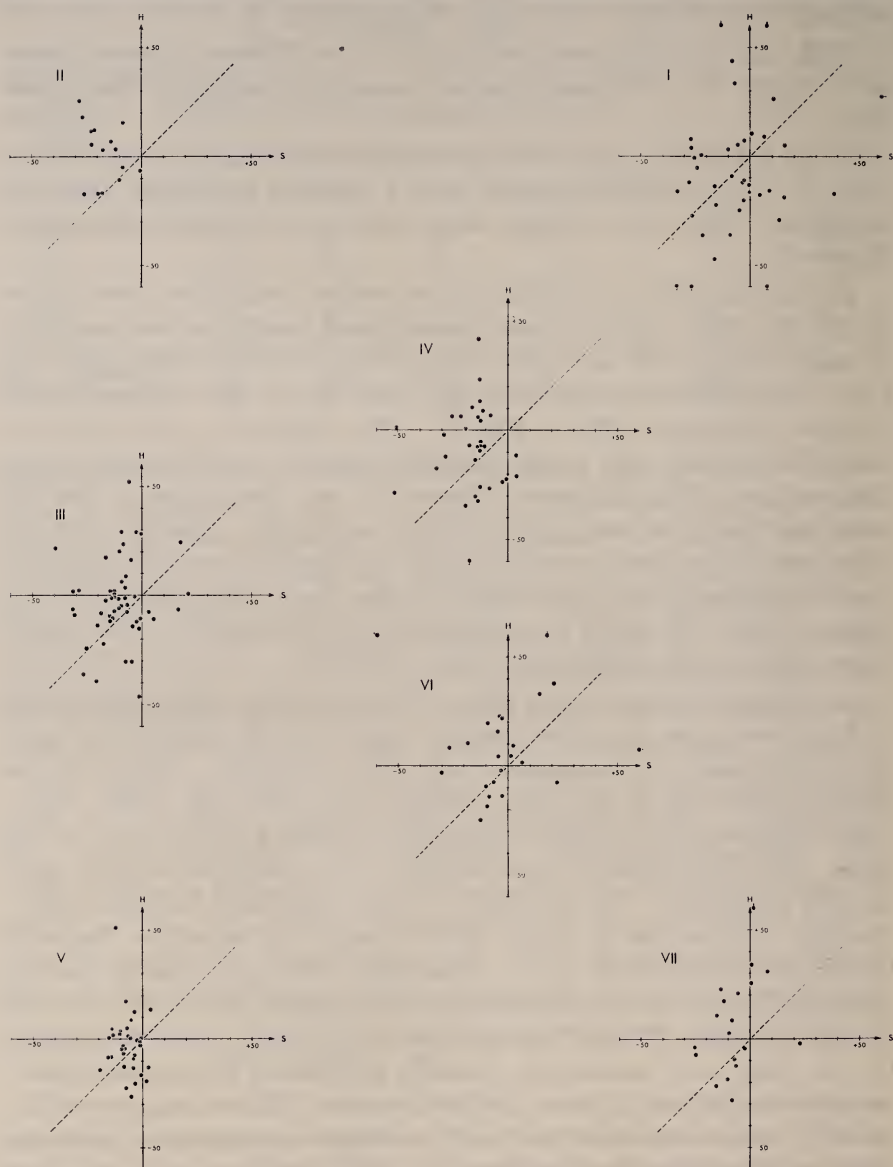


Fig. 4. Relationship between population changes in the hamlets (H) and their surrounding townships (S) by regions in Minnesota, 1940—1950. Regions I—VII the same as in Fig. 5.

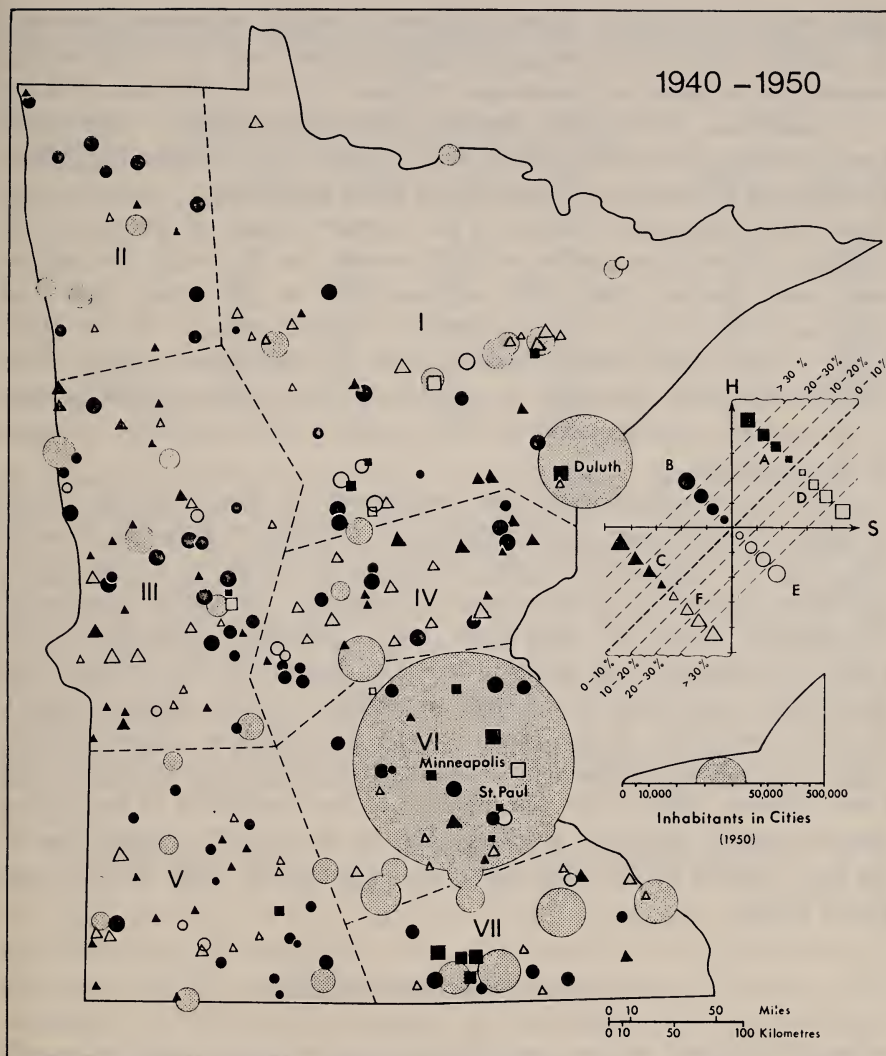


Fig. 5. Types of population change in the hamlets (H) and their surrounding townships (S) in Minnesota, 1940-1950.

much the same, which is also revealed by the small size of the symbols on the map (Fig. 5).

Taken as a whole, the pattern of population change in the hamlets and their vicinities was areally more diverse in 1940-1950 than in the preceding decade. Around the towns of more than 5,000 inhabi-

tants, there is a zone of varying breadth in which suburbanization had the general effect of causing both the hamlets and the surrounding countryside to grow (cf., Hassinger 1957, pp. 131—136; Rikkinen 1968 b).

In addition, there were regional differences along a north-south line. According to the analysis, it would appear as if outside the sphere of influence of towns with more than 5,000 inhabitants, hamlets maintained their importance better in the northern parts of the state both as places of residence and as service centers. In the north the population trend during 1940—1950 corresponded to the trend that had prevailed in the more southern districts a decade earlier. On the other hand, in the most densely settled parts of Minnesota, which were, furthermore, most favorable to agriculture, the developmental pattern in the hamlets corresponded on the average to the population changes in the townships.

The developmental hypothesis expounded in the foregoing, which is especially significant in explaining the differences between areas II and V, is in harmony with the trend of development in the traffic conditions prevailing in these areas. Passenger car traffic superseded the railroad service on local lines first in southern Minnesota. This might be interpreted as meaning that the farmers in this region were the first to be released from their dependence on the nearest hamlet. On the other hand, in the north, where the distances between places were long and the standard of living of farm operators was appreciably lower (Nelson 1960, p. 73), the mobility of the population at this period was not equally great (cf., Rikkinen 1968 a, pp. 34—37); in other words, the last vestiges of the traditional rural community could still be seen in the north.

6. THE 1950—1960 PERIOD

The population trend in the hamlets and their environs continued during the decade of 1950—1960 roughly along the same lines as during the preceding decade (cf., Figs. 4, 6 and 5, 7). A detailed analysis of the various regional sub-divisions will, however, reveal differences.

The number of hamlets decreasing in population (58.1 %) will be seen to have grown only slightly in comparison with the preceding decade. Greater differences may be perceived, though, in the regional distribution. The diminishing trend in population in the hamlets became accelerated in the northern areas (I—III). The greatest change

Table 3. Number of types of population change in the hamlets and their surrounding townships in Minnesota, 1950—1960. For explanations compare text, and Figs. 1 and 7.

Type of population change	Difference in population change between hamlets and their surroundings (Per cent)				Total	
	0—9.9	10—19.9	20—29.9	>30	Number	Per cent
A	8	7	4	4	23	9.7
B	7	29	13	16	65	27.5
C	29	12	2	1	44	18.6
D	5	1	3	2	11	4.7
E	2	8	4	8	22	9.3
F	36	24	7	4	71	30.1
Total	Number	87	81	33	236	100.0
	Per cent	36.9	34.3	14.0	14.8	100.0

in a negative direction occurred in area II, where the hamlets had for the most part still tended to grow in the period 1940—1950. In areas IV—V and VII the pattern of population change remained the same as it had been during the preceding decade. The areas of Minnesota undergoing most rapid urbanization, VI—VII, deviate from all the rest in that here the majority of the hamlets grew in size. In the area of the Twin Cities (VI) the population trend in the hamlets was on the average some 5 % more positive than it had been in 1940—1950. This general pattern of hamlet population change applies equally to villages with between 250 and 1,000 inhabitants (cf., Hart and Salisbury 1965, p. 143).

The population trend in the environs of the hamlets exhibits a close similarity to what it had been ten years before. That is to say, the prevailing decrease in the population of the rural surroundings of the hamlets continued throughout most of the state at an average rate of between 5 and 15 %. The metropolitan area once more, however, is an exception, for there about one-half the townships grew in population. This is a consequence not only of suburbanization but also of urban dispersion, which is the latest development in the phenomenon of urbanization in the automobile era. In the 1950's the »dispersed non-farm population» grew rapidly in Minnesota (Borchert, Anding and Gidemeister 1964, pp. 2—3).

If, again, we compare the population changes in the hamlets with those in their environs, we see that for the most part (65.5 %) the trend remains to this day more positive in the latter (cf., Table 3). In this respect, no great change occurred in comparison with the two preceding

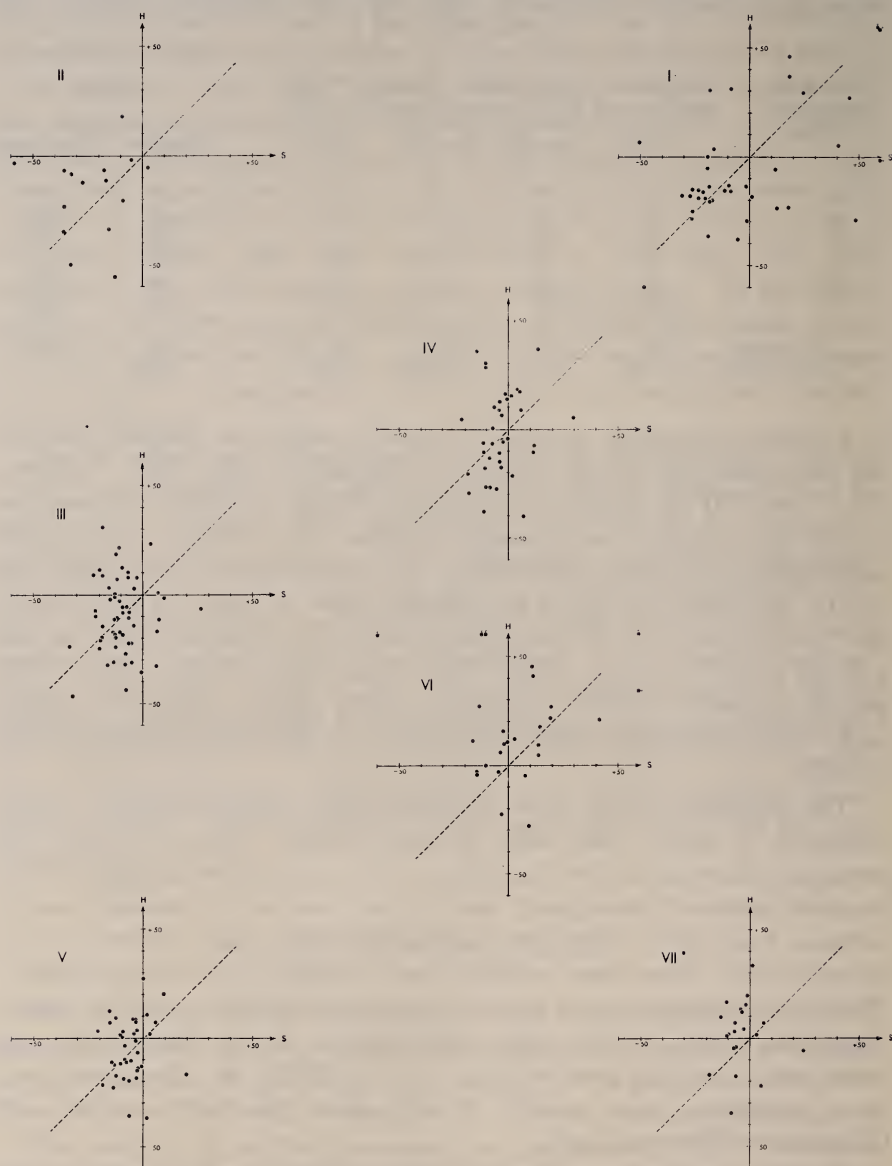


Fig. 6. Relationship between population changes in the hamlets (H) and their surrounding townships (S) by regions in Minnesota, 1950–1960. Regions I–VII the same as in Fig. 7.

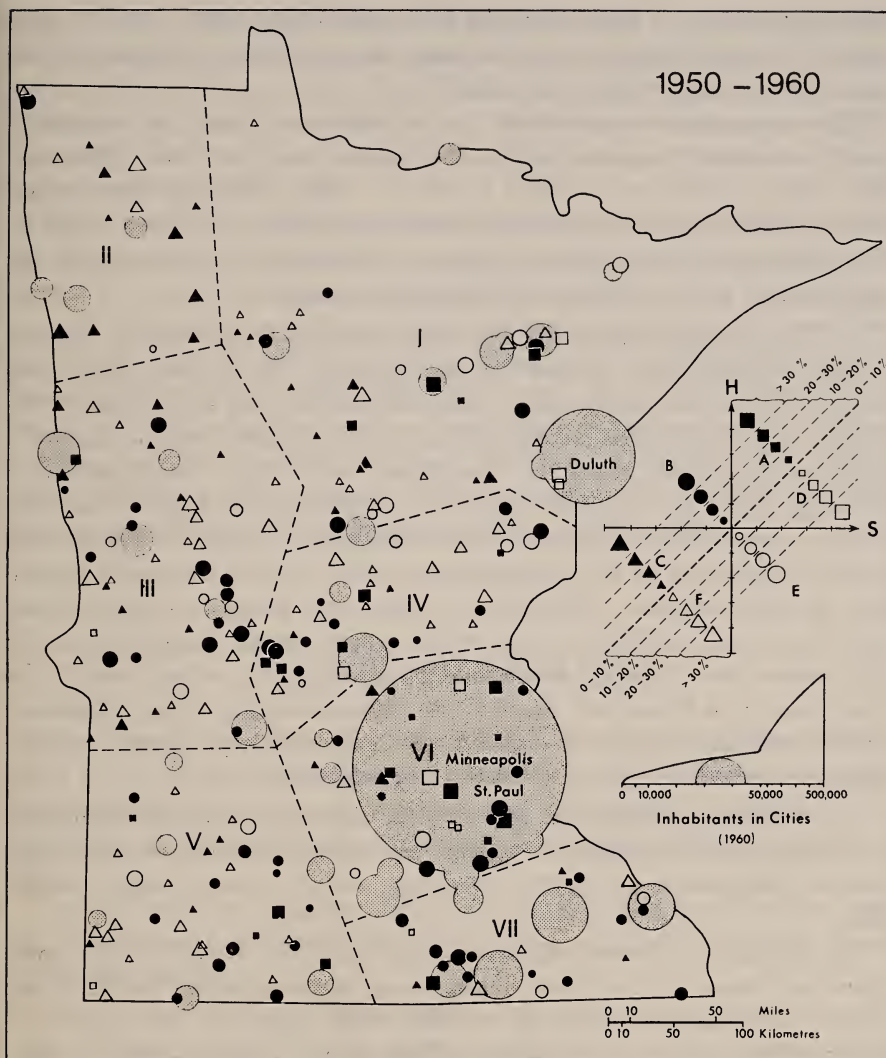


Fig. 7. Types of population change in the hamlets (H) and their surrounding townships (S) in Minnesota, 1950-1960.

decades (cf., Tables 1 and 2). On the other hand, it will be observed that the difference in population trend between the hamlets and their environs diminished compared to the earlier decades. Thus, for instance, the proportion of hamlets where the difference in population change relative to their townships is less than 20 % increased as follows:

1930—1940, 57.0 %; 1940—1950, 59.8 %; and 1950—1960, 71.2 %. This trend is visually apparent on the maps as an average decrease in the size of the symbols (Figs. 3, 5 and 7).

The proportions represented by the different types of population trends remained approximately unchanged in the 1940—1950 and 1950—1960 periods (cf., Tables 2 and 3). The following observations may be made concerning their territorial distribution (cf., Figs. 5 and 7).

1) Generally, the different types are scattered over the area of the whole state, just as during the preceding decade.

2) The hamlets exhibiting the most conspicuous growth in relation to their environs are situated for the most part within the commuting range of cities with more than 5,000 inhabitants, just as in 1940—1950. In addition, it should be noted that also many hamlets with a markedly negative population trend in comparison with the countryside surrounding them are similarly situated. Around the Twin Cities and Duluth, there are, for instance, cases belonging to type D. These cases can be understood as the consequence of the natural territorial expansion of urban centers. Hamlets are often very small in area and lack room for more building to accomodate rapid urban expansion, so for this reason new housing developments spring up in what used to be »open country». Moreover, there is the phenomenon of urban dispersion already referred to, which reflects the aspirations of people to gain »elbow room» and to live in natural surroundings.

3) Outside the sphere of influence of the big cities, the differences in the patterns of population change prevailing between northern and southern Minnesota during the preceding decade are no longer noticeable.

All things considered, distance from big cities was thus the most important factor in the 1950's determining the population trends in the hamlets and their environs, as has also been observed with respect to larger villages (Hart and Salisbury 1965, p. 157; Adams 1964, pp. 42—43). Around the big cities there are growth zones where the population changes of both the hamlets and their townships varied considerably, depending on the local circumstances. Ascertaining the causes of population growth or decline would involve a study of each hamlet as a separate case. In a detailed investigation of the vicinity of Duluth, it was ascertained that the influence of the city on the population changes in the villages and rural areas extended considerably farther during the 1950's than in the preceding decade (Rikkinen 1968 b). Thus, although

in Canada the small trade center has been observed to have lost most of its importance in retail service around large centers (Hodge 1965, pp. 98, 113—114, 1966, pp. 193—195), in Minnesota they have nevertheless, in many cases, grown in population. Many hamlets have accordingly completely lost the functions for which they were originally built (cf., Borchert 1963, pp. 17—18).

There prevails a marked positive correlation between the hamlets and their environs beyond the commuting range of the big cities with respect to population changes. This holds true not only of the southern parts of Minnesota, as in the preceding decade, but also in the northern parts of the state. In other words, the differences in their developmental patterns discerned in 1940—1950, which were due to the differences in the standard of living and mode of settlement of the two regions, appear to have evened out during the last decade considered in the present paper. This line of development runs parallel to the changes that took place in passenger traffic (Rikkinen 1968 a, pp. 44—46).

7. CONCLUDING REMARKS

The central objective of this study was to elucidate the population trend of the hamlets of Minnesota in relation to that of their environs. Toward this end, a simple graphic and cartographic technique was devised to analyze population changes from many different points of view.

In the different decades studied, the percentages recorded for hamlets in which the population increased were as follows (types A, B and D; Tables 1—3):

1930—1940	71.2 %
1940—1950	43.4 %
1950—1960	41.9 %

The percentages recorded for hamlets in which the population trend was more positive than that of their surrounding townships were as following in the different decades (types A, B and C; Tables 1—3):

1930—1940	66.7 %
1940—1950	65.0 %
1950—1960	55.9 %

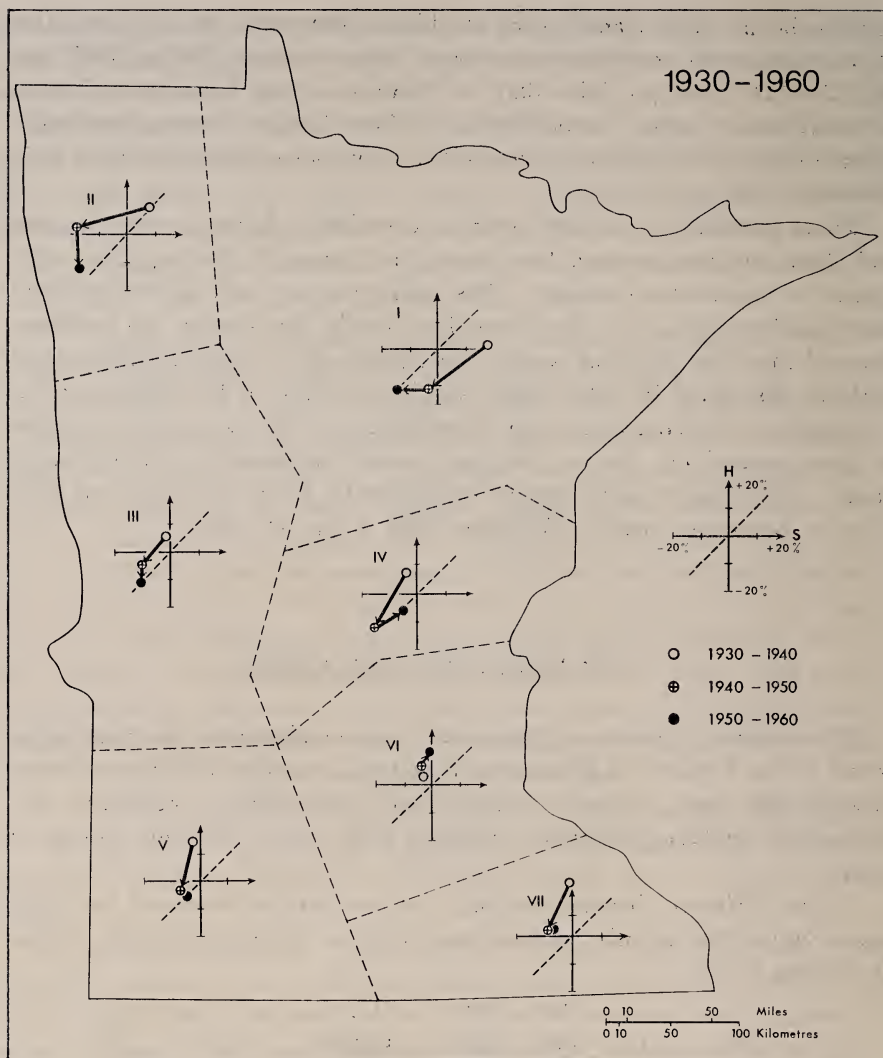


Fig. 8. Median population changes in the hamlets (H) and their surrounding townships (S) by regions in Minnesota by ten-year periods, 1930-1960.

Accordingly, in most cases the hamlets, though on the average they have steadily declined in population, have remained more positive than their »rural» surroundings with respect to population change. The figures cited in the foregoing, however, give only a rough picture of developments, which are characterized by great diversity and vary

spatially and temporally. One must firmly support the statement that the »pattern of village population growth is too complex to be satisfactorily explained by any simple set of statistical variables» (Hart and Salisbury 1960, p. 140). In spite of this, it has been possible to find certain types of population trends and regional patterns characteristic of each period.

An attempt has been made to depict developmental patterns for the entire period covered by the study in the accompanying map (Fig. 8). It shows the average population changes in the hamlets and their environs in the various parts of Minnesota by ten-year periods. The median for all the cases has been chosen as the average for each ten-year period in the diagrams contained in the map.

In the 1930's many features of the so-called traditional rural community were still left. The majority of the hamlets were still growing. Moreover, the population growth of the majority of the hamlets was substantially more rapid than that of the townships surrounding them. The exception is the forested region (1), where, owing to the economic slump, the agricultural population continued to increase appreciably through the clearance of new land. The effects of the Great Depression were likewise felt in the form of slow growth in the big cities, while few »suburban hamlets» were spawned.

In the 1940's the mobility of the population increased, causing an increase in migration. Simultaneously, there took place a marked downward trend in the population of both hamlets and surroundings. Distance to the nearest big city became a factor that during this decade decisively influenced the population trend of the hamlets and their environs. The hamlets within commuting range grew in those cases where building space was still available. Beyond the commuting range a difference could be observed between the northern and southern parts of Minnesota. The hamlets of northern Minnesota appeared to be undergoing a more favorable population trend in relation to their surrounding townships than those in the densely settled and economically more advanced areas in the south. These regions seemed to be experiencing different stages of development.

In the 1950's the influence of the large cities was extended as the wealth and mobility of their citizens increased. Examined in the light of individual cases, the situation in the surroundings of the large cities appeared to have great diversity. This was due to, among other things, the differences in the amount of building space available and to urban

dispersion. Outside the commuting range of the cities, there was a marked positive correlation between the hamlets and their environs with respect to population changes. The diagrams in Fig. 8 show that, taken more generally, too, the average differences between the population changes in the hamlets and their environs have decreased since the days of the traditional rural community.

REFERENCES

- Adams, Russell B. (1964). Population mobility in the Upper Midwest. *Upper Midwest Economic Study, Urban Report 6*, I—VIII, 1—60.
- Borchert, John R. (1963). The urbanization of the Upper Midwest: 1930—1960. *Upper Midwest Economic Study, Urban Report 2*, I—VI, 1—56.
- Borchert, John R. and Adams, Russell B. (1963). Trade centers and trade areas of Upper Midwest. *Upper Midwest Economic Study, Urban Report 3*, I—VI, 1—44.
- » — (1964). Projected urban growth in the Upper Midwest: 1960—1975. *Upper Midwest Economic Study, Urban Report 8*, I—V, 1—36.
- Borchert, John R., Anding, Thomas L. and Gildemeister, Morris (1964). Urban dispersal in the Upper Midwest. *Upper Midwest Economic Study, Urban Report 7*, I—V, 1—24.
- Brunner, Edmund deS. (1952). The small village: 1940—1950. *Rural Sociology* 17, 127—131.
- Brunner, Edmund deS. and Smith, T. Lynn (1944). Village growth and decline, 1930—1940 *Rural Sociology* 9, 103—115.
- Fuguitt, Glenn V. (1963). The city and countryside. *Rural Sociology* 28, 246—261.
- Hart, John Fraser and Salisbury Neil E. (1965). Population change in Middle Western villages: a statistical approach. *Annals of the Association of American Geographers* 55, 140—160.
- Hassinger Edward W. (1956). *Factors associated with population changes in agricultural trade centers in southern Minnesota*. XIII + 277 p. Unpublished dissertation, University of Minnesota.
- » — (1957). The relationship of trade-center population change to distance from larger centers in an agricultural area. *Rural Sociology* 22, 131—136.
- Hodge, Gerald (1965). The prediction of trade center viability in the Great Plains. *The Regional Science Association Papers* 15, 87—115.
- » — (1966). Do villages grow? Some perspectives and predictions. *Rural Sociology* 31, 183—196.
- Knudtson, Arvid C. and Cox, Rex W. (1962). Upper Midwest agriculture: structure and problems. *Upper Midwest Economic Study, Study Paper 3*, I—VI, 1—42.
- Lively, C. E. (1932). Growth and decline of farm trade centers in Minnesota, 1905—1930. *University of Minnesota, Agricultural Experiment Station, Bulletin* 287, 1—48.

- Nelson, Lowry (1960). *The Minnesota community: country and town in transition*. VII + 175 p. Minneapolis.
- Nelson, Lowry and Clappitt, Hazel (1945). Population trends in Minnesota, 1940. *University of Minnesota, Agricultural Experiment Station, Bulletin* 387, 1—39.
- Nelson Lowry and Jacobson Ernst T. (1941). Recent changes in farm trade centers of Minnesota. *Rural Sociology* 6, 99—106.
- Northam, Ray M. (1963). Declining urban centers in the United States: 1940—1960. *Annals of the Association of American Geographers* 53, 50—59.
- Photiadis, John D. (1963). Population of Minnesota, 1950—1960. *University of Minnesota, Agricultural Experiment Station, Bulletin* 468, 1—32.
- Ramsey, Charles E., Orman, Allan D. and Nelson, Lowry (1954). Migration in Minnesota, 1940—50. *University of Minnesota, Agricultural Experiment Station, Bulletin* 422, 1—16.
- Ratcliffe, S. C. (1942). Size as a factor in population changes of incorporated hamlets and villages, 1930—1940. *Rural Sociology* 7, 318—328.
- Rikkinen, Kalevi (1968 a). Decline of railroad passenger service in Minnesota. *Acta Geographica* 19: 3, 1—52.
- » — (1968 b). Changes in village and rural population with distance from Duluth. *Economic Geography*, in press.
- Salisbury, Neil E. and Rushton, Gerard (1963). Growth and decline of Iowa villages: a pilot study. *Department of Geography, State University of Iowa, Publication* 4, I—X, 1—89.
- Trewartha, Glenn T. (1941). The unincorporated hamlet: an analysis of data sources. *Rural Sociology* 6, 35—42.
- » — (1943). The unincorporated hamlet: one element in the American settlement fabric. *Annals of the Association of American Geographers* 33, 32—81.
- Ullman, Edward L. (1957). *American commodity flow: a geographic interpretation of rail and water traffic based on principles of spatial interchange*. XXII + 215 p. Seattle.
- Zimmerman, Carle C. (1930). Farm trade centers in Minnesota, 1905—29. *University of Minnesota, Agricultural Experiment Station, Bulletin* 269, 1—70.

ACTA GEOGRAPHICA 19, N:o 5

**KALEVALA, MINNESOTA:
AGRICULTURAL GEOGRAPHY
IN TRANSITION**

BY
KALEVI RIKKINEN

HELSINKI 1969

Presented the 15th of November 1968
by George J. Demko and Stig Jaatinen

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ABSTRACT

The study analyzes micro scale agricultural trends in Kalevala Township — an area of northern Minnesota — during a thirty-six year period of time. The specific orientation of the study is directed toward changes in the number and type of livestock as well as changes in farm acreage. The primary source materials which have been used are various local tax documents. By employing data relating to taxable real and personal property it has been possible to construct a fairly accurate picture of the structural and spatial situation of agriculture for the designated profile years (1930, 1940, 1950, 1960 and 1966). In this way the trends experienced over the entire thirty-six year period have been revealed.

During every time period Kalevala Township has been compared to larger areas of measure. As a whole, the general trends which have been evident in the township throughout the study fall between those of the most northern area of Minnesota (the Cutover) and the remainder of the state. The general trends, however, only serve to depict the hypothetical »average farm«. The study indicates, on the other hand, that during the latter years, farm differentiation, followed by specialization, has occurred so rapidly from year to year that the average farm now corresponds even less to the actual conditions in the field. The true picture, therefore, can only be seen by viewing the situation in micro scale.

I. INTRODUCTION

1. MACRO AND MICRO SCALE IN AGRICULTURAL GEOGRAPHY

Certain trends in the evolutionary development of agriculture, such as mechanization, increasing farm size and other related phenomena, are more or less universal. These trends, usually revealed on the *macro scale* level, are quite well known and documented. As such, the transition in agriculture is discernable in most statistical material which utilizes some governmental unit as the basic study area.

At the same time, however, a more detailed analysis can be made on the *micro scale* level by employing data related to individual farm

units. When considering this more intimate scale, agricultural statistics only give a very general picture of the situation. Therefore, it is necessary to utilize field observations, interviews and local documents to secure adequate information for such individual farm unit studies.

Two Minnesota geographers, Matti Kaups and Cotton Mather, have recently stated (1968, p. 57): »Precise analytical studies on the micro scale that have been made in the United States are rare...» Nevertheless, this type of study is important since an analysis of individual farm units best describes the actual processes at work in an area. Information related to the micro scale is also important since it is always possible that certain facts will be lost within the context of macro scale generalizations.

The purpose of this investigation, therefore, is to make a micro scale analysis of agricultural trends in an area of northern Minnesota over a thirty-six year period of time. As will be seen, however, the study is limited to only some aspects of agricultural geography, namely, the changes experienced in livestock or cattle farms.

2. SPECIFIC PURPOSE OF THE STUDY

Since only livestock farms will be considered herewith, the specific orientation of the study will be directed toward changes in the number and type of livestock as well as changes in acreage. Those agricultural units which produce some sort of product but do not contain any livestock are quite rare in the study area and have been left out of the analysis. Rural non-farm residences are also not considered, except for those which are somehow closely related to changes in the livestock farms.

In terms of time, the study covers the period from 1930 to 1966. To describe the modulations during the period more succinctly, cross-sectional comparisons will be made by employing data from five different years — 1930, 1940, 1950, 1960 and 1966.

Spatially, the study area, Kalevala Township, is located within one of the »rural problem areas» of the United States (Nelson 1960, p. 126). Throughout the entire investigation an attempt will be made to compare changes in Kalevala Township with discernable trends on the macro scale. Nevertheless, the trends which are evident in this micro scale analysis will not be used to offer a complete or specific description of the »Cutover» area since Professor Stig Jaatinen will be able to

make this determination more concisely by utilizing material based upon a broad sampling of the over-all region. After his study is completed it will then be possible to secure a specific picture of the entire Cutover area and evaluate the more generalized view presented in this paper.

3. SOURCES

One of the major aspects of this investigation involves a presentation of those documents which have relevance in such a genetic study at the micro level. The primary source materials used were different tax books which are maintained for Carlton County, of which Kalevala Township is a part. These documents, which are kept in the Carlton County Courthouse, were kindly made available for the author's use during the summer of 1967. The tax books proved to be a reliable source of information in determining changes on the micro scale level over an extended period of time.

The material for this study has been derived almost entirely from three series of documents:

1. *Assessment Books of Taxable Real Property.* This is a yearly inventory which shows which land tracts are taxed and for what amount. In practice, the taxes are usually assessed in terms of forty acre tracts, the basic unit of areal measure in rural Minnesota. Data are also available for those instances where the forty acres (one-sixteenth of a section) are divided among several owners. From these sources it has been possible to construct a land ownership map for the years 1930 and 1940.

2. *Assessment Books of Personal Property.* In these books there is information concerning the ownership of individual property which is subject to taxation as well as the amount of the levy. The books provided a large amount of information as is evident from the following: (a) It was possible to derive data related to the number of livestock (for instance, the number of cattle by age category and the total number of horses) for practically every year of the study (see Appendix I). (b) Also, 1950 information concerning those tracts where the owner lives on his own property (homestead) and where he lives elsewhere (non-homestead) was available. For some years the information is directly stated while for other years it can be determined by viewing the tax percentages since the proportion is larger for the non-homesteaded property. (c) Also available from this source is the

yearly assessed evaluation as well as the true and full value of cattle, machinery and other taxable personal property.

3. *Property Record and Appraisal Cards.* These cards are made for almost every forty acre tract as in the Assessment Books of Taxable Real Property. The cards contain much information related to these small land areas. It has thereby been possible to derive the following data: (a) The ownership of every land tract for 1950, 1960 and 1966 has been identified. A land ownership map has been made by utilizing this information. The cards have also been used in place of the Assessment Books of Taxable Real Property which showed ownership for 1930 and 1940.¹ (b) Changes in land ownership and the exact date of transaction are also depicted. (c) Every tract has been described in terms of four major land uses — tillable, permanent pasture or meadow, timber or wood lot, and waste and roads. The tillable land has, in addition, been broken down into three subgroupings based on fertility (A, B and C). (d) Information concerning structures (farm buildings etc.) is available for each tract as well as the year of construction. Nevertheless, the information has its limitations since the cards in this particular instance have not been filled in carefully. Also, in many cases it has been difficult to determine whether a new building has been constructed or if only repairs have been made.

By employing all of the above-mentioned material it has been possible to construct a fairly accurate picture of the structural and spatial situation of agriculture for the designated profile years (1930, 1940, 1950, 1960 and 1966). In this way trends experienced over the entire thirty-six year period of time have been revealed.

In collecting data it was not possible to limit the study strictly to Kalevala since some farmers owned land outside of the township. This fact has been considered by checking land ownership in those townships which border Kalevala. While it is possible that other areas are located outside of this approximate six mile limit, it can be assumed that they do not serve as active agricultural units. Therefore those tracts outside of the six-mile limit will always be excluded. On the other hand, whenever the area of a single farm or the average acreage is mentioned (for example in Appendixes II and III), the areas within the six mile boundary will be included.

¹ Property Record and Appraisal Cards were used as the source for 1950, 1960, and 1966 because of more detailed data available on them.

All three primary sources contain much information relative to land, buildings, cattle and other property tax values. The tax values, however, fluctuate almost from year to year as the monetary requirements of the county change. In addition, a somewhat remarkable variation in tax values occurs whenever there is a change of assessors. Such variations, of course, do not give an accurate picture of the true value of the land. Therefore, this extensive numerical material, which is so important to the assessors, has been used only to a limited degree in the study.

II. GENERAL SETTING OF KALEVALA

1. PHYSICAL SETTING

Kalevala Township is located in northern Minnesota, about thirty miles west of Duluth (Figs. 1 and 2). The southern part of Minnesota is densely settled and comprises, along with the far western area of the state, one of the most productive agricultural sectors in the nation. Northeastern Minnesota, however, is relatively sparsely populated and is characterized by large forested areas. At the same time, climatic conditions in the latter area, while not denying the pursuit of agriculture, do provide some rather confining restraints. Kalevala Township is located in a transitional zone between these two areas (Fig. 1).

A quite accurate picture of areal climatic conditions may be derived by utilizing figures from the Cloquet Experimental Forest Weather Station, located some fifteen miles from the center of Kalevala (Fig. 2). Regionally speaking the climate is classified as continental (Fig. 3). The average mean annual temperature is 39.2°F. July is the warmest month of the year with a mean temperature of 66.7°F. Kalevala has great extremes in temperature, not only from season to season and month to month, but on a diurnal basis as well (Baker and Strub 1965, Appendix Table 2).

The length of the frost free season is of great importance to farmers. The average number of days between the last light frost in the spring and the first in the fall is 89, between moderate frosts 113, and between heavy frosts 127. Snow usually begins in late October and lasts until early May (Scantz-Hansen and Jensen 1956, pp. 6—8).



Fig. 1. Location of Kalevala Township. The shaded region, the »Northern Forested Area», could also be called the »Northern Cutover Dairy Area» and is adopted from Engene and Pond (1940, p. 46; also Nelson 1960, p. 16 and Knudtson *et al.* 1962, pp. 5—6) The area consists of the following 13 counties: Aitkin, Beltrami, Carlton, Cass, Clearwater, Cook, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Lake of the Woods and St. Louis.

There is only a twenty percent probability that a temperature of 16°F or lower occurs on or after the 26th of April (Baker and Strub 1963 a, p. 16). In summary, the »total crop season» or the average period between the commencement dates of early spring and winter consists of 175 days (Baker and Strub 1963 b, p. 22).

Kalevala has a steep summer rainfall gradient (Fig. 3). On the average 76.6 percent of the annual precipitation of 29.12 inches comes during the five month period from May 1 to September 30 (Baker *et al.* 1967, Appendix Table 1). Generally, Kalevala Township's moisture supply is adequate for any agricultural purpose. During many years it has been too sufficient rather than too little.

Since every plant grows best under certain optimal climatic conditions, the highest and lowest temperatures experienced in Kalevala Township are important factors in determining the number and type of crops that can be raised. It is possible to determine this optimal range by counting the so-called »effective day and night temperatures» or »phototemperature and nyctotemperature» (Baker and Strub 1965, p. 21). For example, it may be concluded that on the basis of the

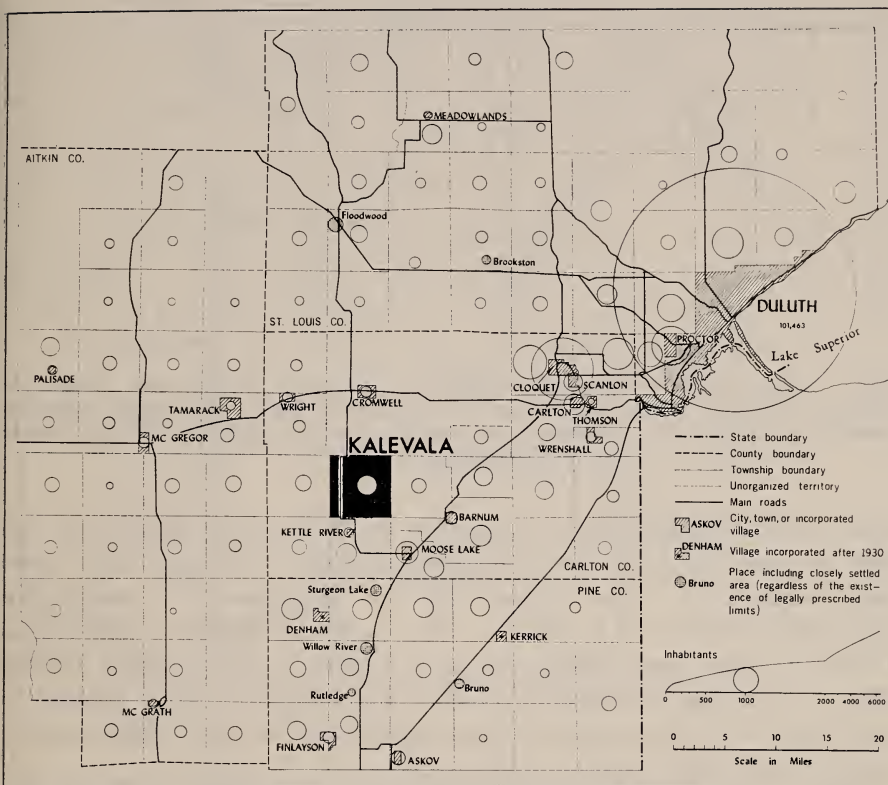


Fig. 2. The location of Kalevala Township in relation to its immediate surroundings. Also shown are the major roads and the distribution of population by small civil divisions for 1930.

Cloquet Weather Stations's day and night time temperatures, growing conditions for corn and sugar beets are, during an average year, far from ideal. The raising of these crops is especially restricted because of low night time temperatures. On the other hand, conditions for the growing of potatoes and flax are almost optimal while barley and oats have relatively few constraints (*op. cit.*, pp. 21—27, Appendix Table 2). In essence, it might be said that because of climatic factors fodder producing crops can be most readily grown in the area.

While climatic conditions provide certain general limitations in terms of crop production, some specific areas of the township are further restricted because of soil factors. Since the surface formations of Kalevala have developed upon a relatively thick mantle of

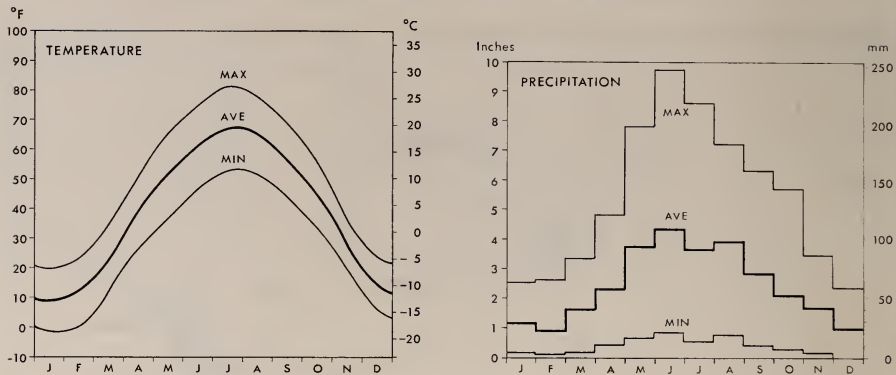


Fig. 3. Left: Yearly maximum, average and minimum temperature curves for Cloquet, 1931–60 (Baker and Strub 1965, Appendix Table 2). Right: Monthly maximum, average and minimum total precipitation for Cloquet, 1931–60 (Baker *et al.* 1967, Appendix Table 1).

loose material (glacial drift) deposited by the melting glaciers of the last ice age, the soils are a complex mixture of stoney loam, peat bogs, sandy plains and ridges, and wet clay loams in saucer-like depressions (Pond and Crickman 1933, pp. 9–10; Borchert 1958, Maps 1 and 2). The land surface of the township is only slightly rolling (Fig. 4) and the topography provides few limitations with respect to agriculture. The greatest variation is provided by the erosive action of the Kettle River and its tributaries.

The level but somewhat higher areas of the township were originally covered by coniferous and hardwood forests. At the present time, however, aspen predominates (Sandberg *et al.* 1950, pp. 10–11; also compare Hansen *et al.* 1936; Cunningham *et al.* 1958, Appendix Map). The lower areas are wet and swampy and are not suitable for agriculture unless extensively drained. The general effects of the township's physical features are revealed in greater detail in the land use maps.

2. OCCUPANCE OF THE LAND AND LAND USE PATTERNS

During the middle of the nineteenth century, settlement spread over southern Minnesota (the most favorable area in terms of agriculture) and rapidly moved from east to west to the area where insufficient rainfall began to limit crop production. Northeastern Minnesota, however, remained as almost an untouched forested area until the latter third of the century. Fur trappers first penetrated

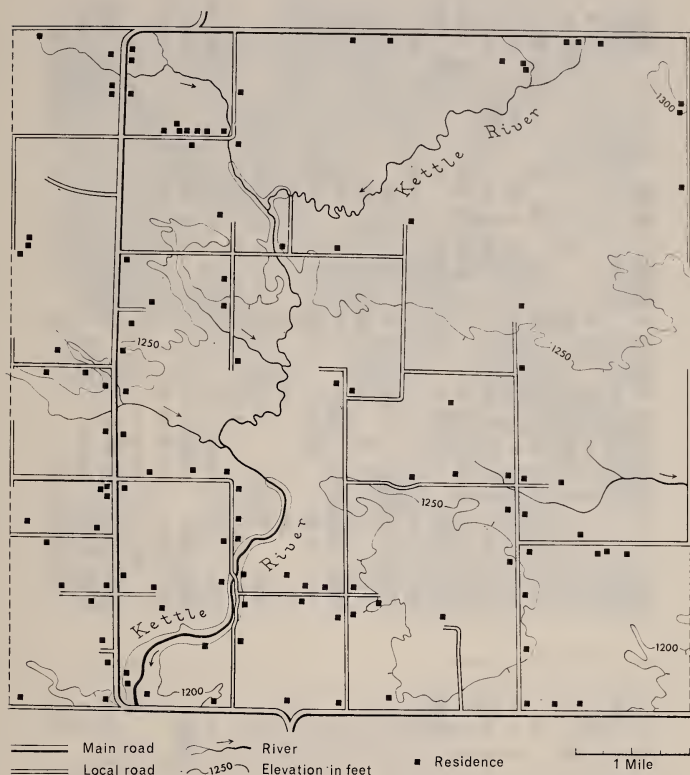


Fig. 4. Roads, residences and major physical features in Kalevala Township: 1966 (after Carlton County Plat Book, 1967).

into the region and were followed by lumbermen who cut the original stand of timber. The best example of this gross act of plundering is reflected in the name given to the present day area — the »Cutover». The lumber industry increased steadily up to about 1905 (Pond and Crickman 1933, p. 19), with the first permanent residents, who hoped to make a living from the land, following the lumbermen.

The first settlers who began to clear fields in Kalevala Township were Finnish immigrants. Although the exact date of their arrival is not clear, the first noticeable activity began in the latter 1800's (Wasastjerna 1957, pp. 751—753; Kaups 1966, Fig. 2). The residents built their first church in 1900 at which time the population totaled 333 persons (U.S. Bureau of the Census 1931). At the present time almost all of the township's residents are of Finnish descent. Even as late as 1946 the telephone exchange servicing Kalevala Township

a. Tillable land



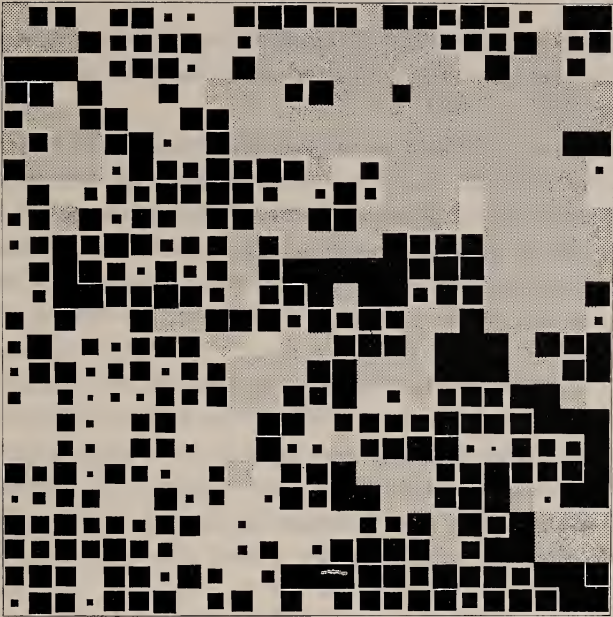
b. Meadow land



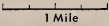
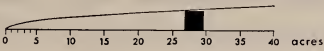
Fig. 5. Land use maps of Kalevala Township: 1950. The size of the symbols are true to scale. Shaded areas are owned by either the state or county (the majority of the land is either poor forest or waste land).

Source: Property Record and Appraisal Cards for Carlton County, 1950.

c. Forest land



d. Waste land



was answered only in Finnish! This situation led to an intense language quarrel when one newspaper raised the issue to a clamorous level (Wasastjerna 1957, p. 754).

The number of residents as well as the clearing of fields continued to increase throughout the first two decades of the century. The development was interrupted, however, during October, 1918, when a destructive forest fire occurred in this area of Minnesota. A total of 2,000 square miles of land was destroyed and 559 persons met their deaths in the state (*op. cit.*, p. 742). The fire and its related havoc also reached to the Kalevala area. V. Niemi (Carlton County) stated in an interview that only one-third of Kalevala's total area was not touched by the fire. This meant that those trees which the lumber companies had not cut during the earlier years were now lost. Even as late as 1949 only four percent of Carlton County's total farm forested area was comprised of sawable (lumber) timber. At that same time, some thirty-one years after the fire, almost one-half of the woodland acreage owned by farmers was covered with understocked stands of tree species as well as brush and scattered areas of grass. While much of the acreage was used as range area for livestock, it was felt, in 1949 at least, that much of the land neither made good pasture nor good woodland (Sandberg *et al.* 1950, pp. 12—13). Hence, the farmers of Kalevala Township were relegated to the task of making their living from the land but without the extra monetary income normally provided by the forests. A touch of irony was added to the situation since Cloquet, the most important wood manufacturing center in Minnesota (Hansen *et al.* 1936, p. 9), was located nearby (Fig. 2).

The maps showing the land use patterns (Figs. 5 a, b, c and d) can be kept as a kind of synthesis of physical factors and land occupancy. The maps show the land use for each individual forty acre tract as revealed by a review of the above-mentioned property records and appraisal cards. Fields, meadows, forests and waste lands are shown for 1950, since it was the first year that such information became available.

The majority of the tillable land (Fig. 5 a) is located in the vicinity of the Kettle River and its tributaries, where the soil is comprised of fine and relatively fertile material. Nevertheless, the fields in the river valley are not large and continuous with various land uses dividing the mosaic into separate islands. The location of the meadows

(Fig. 5 b) reveals a similar pattern. Also, since the majority of the fields are utilized for the raising of hay, they are located proximate to one another.

A large part of Kalevala Township's surface area is covered by forest (Fig. 5 c) and waste land (Fig. 5 d). All of the maps reveal county and state owned lands which have been tax-forfeited because of their worthless wasteland and poor forest composition. The tax forfeited areas, as a whole, are located in the eastern and northeastern parts of the township where the majority of the swamps are also situated.

In summary, it can be said that Kalevala Township is divided into two major land use areas. The fields or cultivated areas are concentrated in the western and southern sectors while the northeastern portion is especially characterized by woods and brush land. Thus, in a detailed sense, the Kalevala area once again reflects its position in Minnesota between the state's agricultural area and the northern forests.

3. POPULATION DEVELOPMENT

By reviewing the population data which are available from 1900 onward, it is possible to see that the number of inhabitants in Kalevala Township increased until 1920, whereupon the figure declined somewhat during the following decade (Fig. 6). Throughout much of the 1930's the extraordinary conditions caused by the depression instigated a relatively large back-to-the-land movement. As a result the population of Kalevala Township reached an all-time census high of 681 persons in 1940. After this the population began to decline rapidly and totaled only 408 residents by 1960 — about the same number as at the beginning of the century.

During the past decades the influence of large urban centers has begun to affect the traditional character of many rural areas. Increases in part-time farming and so-called »urban dispersal» has often resulted in marked population growth. The relation of Kalevala to a large urban center, in this instance, Duluth, can be seen in an article which considers population change in the region from 1930 to 1960 (Rikkinen 1968 b). In the study it was determined that in spite of increased mobility during the past decade, Kalevala Township has been outside the close commuting range of the major employment centers of Duluth and Cloquet (*op. cit.*). Because of this, Kalevala's population has declined since 1940, unlike the situation in Carlton County as a whole

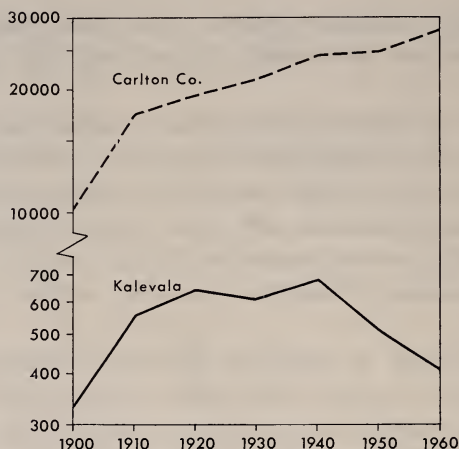


Fig. 6. Population change in Kalevala Township and Carlton County: 1900—1960 (U.S. Bureau of the Census 1931, 1943 and 1967).

(Fig. 6). Carlton County has experienced an over-all increase in population since it is bordered by Duluth on its eastern side and the city of Cloquet is located in the northeastern portion of the county (Fig. 2). Kalevala Township's population development closely follows the average trends which the rural townships located some 30—35 miles from Duluth have experienced during the 1930 to 1960 interim (*op. cit.*) Thus, in Kalevala Township it is possible to study changes in agricultural geography as they occur in a more or less »undisturbed» setting.

III. THE SITUATION IN 1930

The active settlement period of Kalevala Township actually occurred up to the 1920's. After that date the population began to decline for the first time. Thus, and as the study reveals, 1930 represents the time when Kalevala's agricultural settlement had already reached such a static point that hardly a new field was cleared thereafter.

1. LAND OWNERSHIP

In Kalevala Township the pattern of land ownership is usually the result of a measuring system which utilizes regular six by six

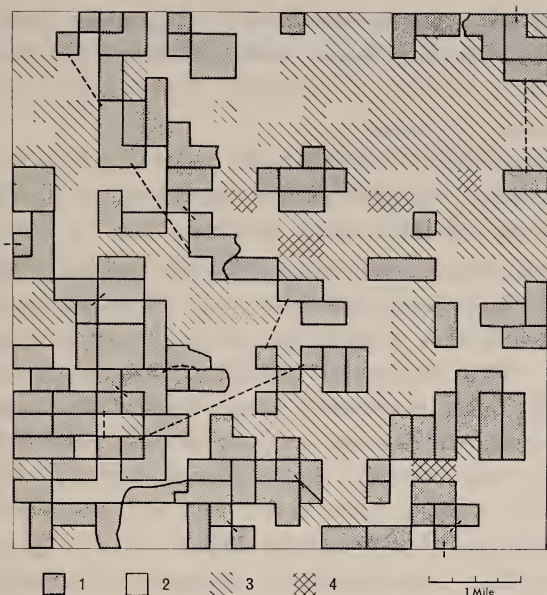


Fig. 7. Land ownership in Kalevala Township: 1930.

1. Land owned by farmers.
2. Non-farm, privately owned land.
3. Land owned by companies and agencies.
4. Land owned by the county or state.

Non-contiguous land areas owned by the same farmer are joined by dashed lines. Dashed lines crossing the township boundary indicate that the farmer owned land outside of Kalevala. Source: Assessment Books of Taxable Real Property for Carlton County, 1930.

mile units (i.e., townships). By using the congressional system of land survey the townships are further divided into thirty-six generally equal sections with every section partitioned into four equal 160 acre tracts for tax purposes. In addition, the 160 acre parcels can be divided into individual forty acre segments. As a result, land ownership in Kalevala Township follows this »checkerboard» pattern quite closely (Fig. 7). About the only exceptions to the regular forty acre system are found in areas which border the Kettle River. Because of its meandering nature, the parcels along the river are often smaller than forty acres in size. Except for these few areas, however, the boundaries are almost exclusively linear. This also reflects the generally level topography of Kalevala Township, as opposed to the rather extreme variations found in southeastern Minnesota (Johnson 1957, p. 345).

By utilizing the Assessment Books of Taxable Real Property it is possible to group the land areas of Kalevala into four major categories:

1. Land owned by farmers
2. Non-farm, privately owned land
3. Land owned by companies and agencies
4. Land owned by the county or state

The farms have been counted by considering only the units which have cattle. For example, those land areas which are owned by retired persons who might have a small potato patch but no cattle, have not been counted. This system of classification appears to be suitable for Kalevala Township since only a very few of the commercial farms had some non-livestock derived product to sell. This is illustrated by the fact that in the entirety of Carlton County, of which Kalevala Township is only a small part, there was not one »cash-grain» farm in 1930 (U.S. Bureau of the Census 1932).

County and state owned land is designated as consisting of those areas which paid no taxes during 1930.

The areal distribution of all four categories is revealed in the accompanying map (Fig. 7). The land owned by farmers comprises approximately 35 percent of the township's total area. As might be expected, the location of the farms is closely related to the distribution of tillable farm land (compare with Fig. 5a). A comparison of land use and field distribution is not directly possible for 1930 since such data were not available until 1950 (Fig. 5). With the exception of six farms, all of the land area for each individual agricultural unit consists of contiguous parcels.

The land owned by private individuals not engaged in farming includes almost as large an area as that held by the farmers. In general their holdings are situated in almost the same zonal areas as the agricultural land. By referring to the land use map (Fig. 5), it can be seen that many of these holdings probably consisted of fields and meadows. It is also probable that even though the owner himself did not use the land for agricultural purposes, he rented the acreage to a neighboring farmer. Rental practices, however, can only be surmised since the tax books do not reveal such information. Many of the individuals who owned land but did not farm it lived in places other than Kalevala Township. This can be concluded by viewing the surnames of the owners since only a very few of the farmers

were not of Finnish origin. The situation with respect to the non-farm owners living mainly outside of Kalevala, will be discussed further in the section which considers the period between 1930 and 1940.

Company or agency owned land embraced approximately one-third of the township's total area in 1930. Of this amount, over ninety percent belonged to one company (The Winona & St. Peter Land Co.). This firm played an important role in the initial settlement of Kalevala Township since they sold land to the farmers. Hence, the land which still belonged to the companies in 1930 consisted almost entirely of non-usable swamps and woodland (compare with Fig. 5).

County and state owned land formed a very small portion of Kalevala's total area in 1930. Also included in the category were school lands and a few tax forfeited parcels which the county had acquired.

The following sections of the report will be limited to studying the structure of farms in Kalevala Township and related changes that have taken place since 1930. As was mentioned before, the other land ownership groups will be discussed only when they directly affect the agricultural situation.

2. NUMBER AND SIZE OF FARMS

In 1930 Kalevala Township contained a total of ninety-four farms. Because of the system of land division, the farms were comprised of basic forty acre units (Fig. 7). Hence, and to facilitate the process of comparison, the farms have been grouped into categories which are multiples of the basic forty acre size (i.e., 40, 80, 120 acres etc., see Appendix II).

The average size of a Kalevala Township farm in 1930 was 87.9 acres. By way of comparison the average farm in Carlton County at that time consisted of 91.4 acres (U.S. Bureau of the Census 1932). The size of the farms was noticeably under the average for Minnesota as a whole which, in 1930, amounted to 166.0 acres. When it is further considered that not even all of the land was tillable and that a significant portion of the fields belonged to the poorest group (C), the predominating small farm character of Kalevala Township is further accentuated.

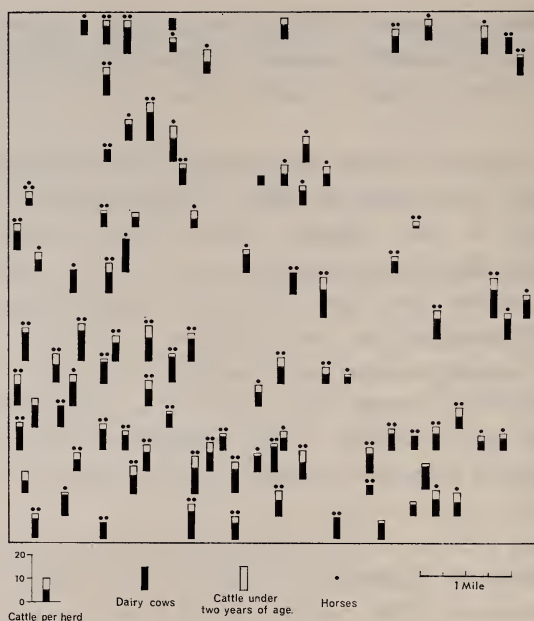


Fig. 8. Size of herds and number of horses by individual farm: 1930.
Source: Assessment Books of Taxable Real Property for Carlton County, 1930.

3. CATTLE

There was a total of 957 cattle in Kalevala Township during 1930. The Assessment Books of Personal Real Property further list the cattle in terms of four age categories (under 1, 1—2, 2—3, and over 3 years). Since dams and sires are also listed separately and since there were no beef cows in Kalevala during 1930, it is possible to place all of the over two year old female animals into the milking cow category. In fact, there were hardly any beef cows in all of Carlton County at that time (Crickman *et al.* 1934, pp. 10—11).

The distribution of cattle and dairy cows in terms of individual farm size can be seen by viewing the scatter diagrams (Appendix III). The number of cattle per farm ranged from three to eighteen with the average herd consisting of 10.2 animals. This corresponds quite closely to the 1930 average of 9.8 cattle per farm for the entire northeastern cutover section of Minnesota (Pond and Crickman 1933, p. 22). There clearly were fewer cattle on the forty acre farms than on

those with greater acreage; however, a comparison of the large farms to one another reveals no such obvious correlation (Appendix III).

The average farm in Kalevala Township had 7.4 milk cows or about one cow more than the average for the Cutover area (*op. cit.*). There was no great dispersion to either side of the average with seventy percent of the farms having five to nine cows. At the same time, there was no clear correlation between acreage and the number of milk cows (Appendix III and Fig. 8).

Since it must be remembered that horses were the primary draft animals in Kalevala Township and northeastern Minnesota at that time (*op. cit.*, p. 59), Figure 8 depicts the number of horses by farm. In 1930 there were 143 horses in Kalevala with only eleven farms having none at all.

4. SUMMARY

Many similarities are evident in Kalevala Township's farms during 1930. Deviations from the median farm, which had an area of eighty acres as well as seven milk cows, three calves and one horse, are not large or great in number. These similarities, in one sense, indicate a relatively long and stable situation. Therefore, in 1930 at least, Kalevala Township still existed as a »traditional rural community» (Fuguitt 1963, p. 247).

IV. CHANGES DURING THE PERIOD FROM 1930—1940

In the 1930's Kalevala Township experienced a population gain of 11.8 percent (Fig. 6), with the rise reflecting the same depression era trends as exhibited throughout Minnesota. During the period rural Minnesota registered an over-all rural population increase of 7.3 percent (U.S. Bureau of the Census 1943). An especially strong back-to-the-land movement was to be seen in northeastern Minnesota because of unemployment in urban centers and industries (Nelson and Clappitt 1945, pp. 21—23; Rikkinen 1968 a, pp. 16—17; 1968 b, pp. 315—317). It has also been stated that the reasons for returning to the land were not so much because of a lack of food or fiber (there actually was an agricultural surplus at this time), »but rather because there was nothing else for people to do» (Nelson 1960, p. 7).

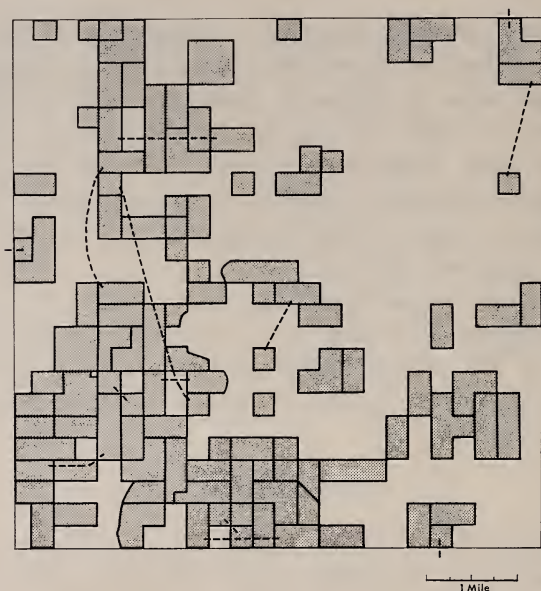


Fig. 9. Land owned by farmers: 1940. Non-contiguous land areas owned by the same farmer are joined by dashed lines.

Source: Assessment Books of Taxable Real Property for Carlton County, 1940.

1. NUMBER AND SIZE FARMS

The number of farms increased by 9.6 percent during the decade and reached a total of 103 in 1940. The gain, however, is less than that for the entire northeastern cutover area (33.5 percent) but a little higher than for all of Minnesota (6.0 percent) (U.S. Bureau of the Census 1942). The land owned by farmers also increased from 8,140 to 8,960 acres.¹ The average farm size of eighty-eight acres remained at about the same level as the previous decade. The figure was also lower than the average northeastern Minnesota farm of 103.5 acres (U.S. Bureau of the Census 1942).

By comparing the farm totals for 1930 and 1940 (Appendix II), it is possible to see that not only the average size of the farms remained

¹ In the 1940 Assessment Books of Real Property there is some incongruity since five farms are not listed. Hence, their areas are not known. To arrive at the total figure it has been assumed that the five farms consisted of eighty acres each — the average for a Kalevala Township farm in 1940.

In this case, as well as later in the report, the lots outside of Kalevala Township are excluded (compare p. 8).

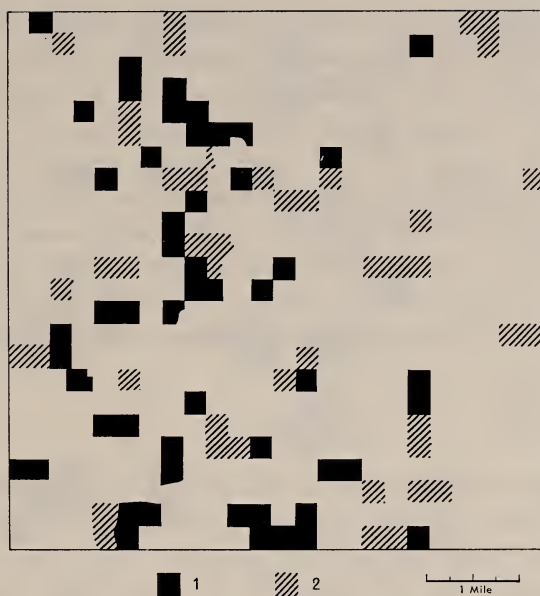


Fig. 10. Changes in land owned by farmers: 1930 to 1940.

1. New land acquired by farmers.
2. Land surrendered by farmers.

Source: Assessment Books of Taxable Real Property for Carlton County, 1930 and 1940.

about the same but that the number of farms in the different size categories also exhibited the same tendency.

Again, an exact comparison of the 1930 and 1940 land ownership maps (Figs. 7 and 9) is somewhat restricted since five of the farms are not shown for the latter date (refer to Footnote 1, p. 24). In spite of this hindrance, it is possible to derive an over-all view of the changes (Fig. 10). Most of the new land taken for farms occurred in areas where former settlement was the densest and where the land was most highly tillable. The land which had passed out of farm ownership during the decade, however, was scattered throughout the township. It can be seen, nevertheless, in relative terms the greatest amount of land passing out of farmers' hands occurred in the eastern portion of the township — the area of poorest agricultural land.

In a study related to forest areas in the Duluth region during the mid-1930's, the pattern and distribution of tax delinquent property was clearly revealed (Allison and Cunningham 1939, p. 12). The study marked those areas for which no taxes had been paid for over



Fig. 11. Tax delinquent land: 1936.

1. Long term delinquent (owned by farmers).
2. Short term delinquent (owned by farmers).
3. Long term delinquent (non-farm, privately owned).
4. Short term delinquent (non-farm, privately owned).
5. Long term delinquent (owned by companies and agencies).
6. Short term delinquent (owned by companies and agencies).

Source: Assessment Book of Taxable Real Property for Carlton County, 1930. Allison and Cunningham (1939, p. 12).

five years («long term delinquent») and those which were assessed in 1935 but with unpaid taxes as of September 1936 («short term delinquent»). This information can be compared to the land ownership map of Kalevala Township for 1930 (Fig. 7). It is possible to see that the main portion of the tax delinquent property was in the hands of private non-farm owners (Fig. 11). During the depression many of these owners had to give up their land holdings in Kalevala Township. As was also described earlier, a large number of the non-farm owners lived outside of Kalevala. The land areas which contributed no tax revenues over an extended period of time eventually reverted to Carlton County.

By comparing Figure 11 to Figure 9 it is obvious that, with the exception of a few parcels, all of the 1936 tax delinquent property which was owned by private non-farm owners in 1930 was in the

hands of farm owners by 1940. On the other hand, just over one-half of the 1936 tax delinquent property owned by farmers in 1930 was still retained by the farm owners in 1940. Therefore, in spite of the fact that much land suitable for agriculture was available in the 1930's, the farmers did not seize the opportunity to increase their holdings. The main reason for this, of course, was the lack of capital (especially because of the low prices paid to farmers during the depression) as well as the agricultural surplus. Having a place to stay which at least provided some form of basic subsistence was more important than attempting to raise some marketable product.

2. CATTLE

There was a total of 1,582 cattle in Kalevala Township during 1940 — an increase of almost forty percent in the years (Appendix I). This increase was larger than the 27.2 percent gain registered for all of northeastern Minnesota (U.S. Bureau of the Census 1942). By comparing the herds in 1930 and 1940 it is also obvious that the average herd size increased noticeably (1930—10.2 cattle: 1940—15.4 cattle). Since the number of cattle per herd ranged from two to thirty-nine in 1940, it is obvious that there is a greater variation from the average than in 1930.

If only dairy cattle are considered, it is evident that herd size did not increase as noticeably (Appendix III). In fact, the average herd increased by only one cow (7.4 to 8.4). It can also be seen that the proportion of small herds (under five cows) decreased while the larger herds (over ten cows) increased. The total milk output did not show a significant gain either since the production per cow increased very slowly during the 1930's. By way of illustration, in Minnesota in 1929 the average cow produced 5,050 pounds of milk — only fifty pounds less than in 1938 (Koller and Jesness 1940, pp. 7—8). Finally, and as in 1930, there was no clear correlation between acreage and the number of dairy cows.

It can also be concluded that between 1930 and 1940 the number of young stock grew appreciably. A comparison of Figures 8 and 12 shows that the number of calves under one year of age especially experienced a significant gain. In 1930 there were only seventy-five calves in Kalevala Township. By 1940, however, the num-

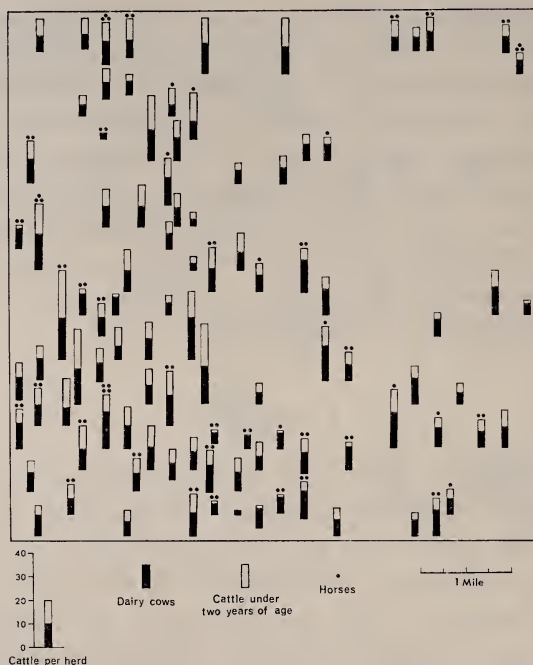


Fig. 12. Size of herds and number of horses by individual farm: 1940.
Source: Assessment Books of Personal Property for Carlton County, 1940.

ber had climbed to 457. The large number in the latter year, nevertheless, is somewhat of an anomaly since the figure decreased by almost one-half during the following year (Appendix I). The rather exceptionally large number of calves on Kalevala Township's farms in 1940 can probably be explained by two facts. First, there was a relatively significant rise in the prices paid to farmers for beef between 1940 and 1941 (Dowell and Brekke 1948, p. 5). No doubt a large number of the animals were sold during 1941 for that purpose. Second, and perhaps most importantly, the figure for 1941 signifies the beginning of the whole milk era in northeastern Minnesota. In the 1930's all but fourteen percent of the milk in the region was separated on the farm with the cream then sold for the manufacture of butter (Mighell and Black 1951, p. 205). The large amount of skim milk available through such an operation provided the basic food for the raising of a large number of calves. By 1945, however, over forty percent of the farmer's product was sold in the form of whole milk

(*op. cit.*). Therefore, the large amount of skim milk available on the farms in the 1930's began to decrease sharply during the following decade.

3. MECHANIZATION

In 1935, during the midst of the depression, the number of horses in Kalevala Township reached an all-time high (150). After this, the total fell so rapidly that by 1940 the remaining ninety-six horses were only found on one-half of the farms (refer to Fig. 12). If the number of horses by individual farm is considered it can be determined that there was no clear correlation between such draft animals and total acreage. The same is true when comparing herd size to the number of horses (Fig. 12). This indicates, for example, that the use of tractors was just beginning since not even the largest farms had converted entirely to mechanical power. An increase in the value of machinery, however, is exhibited between 1939 and 1940 and indicates that mechanization was beginning to play a larger role in the agricultural picture at the end of the decade. In another study concerning technologic change in some southeastern Minnesota farms, it was also seen that a moderate increase in mechanization was exhibited during the entire 1930 to 1940 interim (McDaniel and Pond 1953, pp. 4—7).

4. SUMMARY

Agricultural development during the 1930's bears the distinctive stamp of the depression's unfavorable conditions. The circumstances which predominated during the decade also served to keep people on the farms. While the number of farms increased, their progress was hindered by low prices, a shortage of capital and an agricultural surplus. Needless to say, life was quite static. This is also exhibited by the stability of the various age groups in Kalevala Township between 1930 and 1940 (U.S. Bureau of the Census 1932 and 1943). In spite of the non-fluid situation, however, some differentiations, as in herd size, did occur. The farms in 1940 were no longer as homogeneous as they had been ten years earlier. Also, at the very end of the decade, the first signs of mechanization were noticeable.

V. CHANGES DURING THE PERIOD FROM 1940—1950

During this decade the population of Kalevala Township decreased from 681 to 508 residents — a loss of 25.4 percent (Fig. 6). The decline is similar to population trends experienced in other rural townships outside the direct influence of Duluth (Rikkinen 1968 b, p. 319). The population transition also reflects the emancipation from the rigors of the depression period and depicts the increasing mechanization of agriculture in addition to the sporadic growth of urban oriented activities (Ramsey *et al.* 1954, pp. 2—16). The vast pool of available labor which was to be seen on the farms already in the 1930's (Pond and Crickman 1933, p. 83), was beginning to break its deeply rooted rural bonds.

1. NUMBER AND SIZE OF FARMS

The number of farms decreased by nine to a total of ninety-four in 1940. The loss (9.6 percent) is about the same as for all of Minnesota during the period (9.3 percent) but less than that for the northeastern area of the state (28.0 percent) (U.S. Bureau of the Census 1952). Land owned by farmers increased from 8,960 to 9,840 acres (9.8 percent), even though northeastern Minnesota as a whole experienced a small decline in agricultural acreage (*op. cit.*). This fact tends to indicate that the back-to-the-land tendency of the depression period was not as strong in Kalevala Township as in other parts of the Cutover area.

While the number of farms in Kalevala fell, there was a gain in the amount of agricultural land; therefore, the average farm grew from 88 to 108 acres. In spite of the growth this figure was still noticeably below the state and northeastern Minnesota average farm sizes of 183.6 and 120.2 acres respectively (*op. cit.*). With increasing farm size the proportion of smaller farms, or those from forty to eighty acres, experienced an absolute and relative decline (refer to Appendix II).

Since the above-mentioned source material for 1940 excluded five farms (see Footnote 1, p. 24), an exact comparison with 1950 is not feasible. However, it is possible to analyze exactly the transition from 1930 to 1950 since the total number of farms was the same (94). A most noticeable occurrence which can be seen by comparing Figure 14 and the 1930 land ownership map (Fig. 7) is the rather remarkable

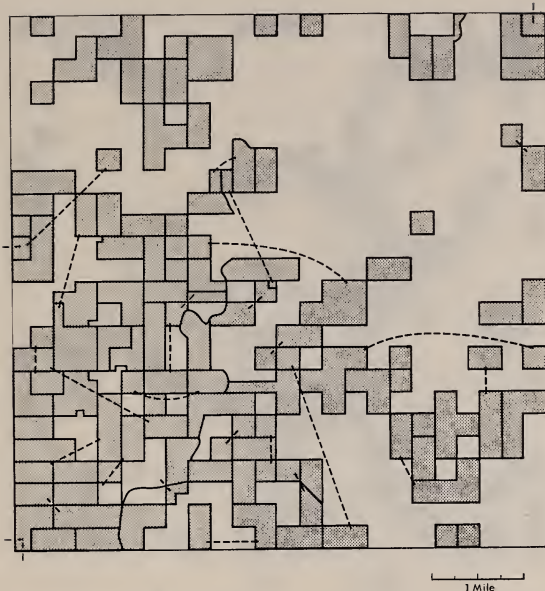


Fig. 13. Land owned by farmers: 1950. Non-contiguous land areas owned by the same farmer are joined by dashed lines.

Source: Property Record and Appraisal Cards for Carlton County, 1950.

change in land owned by farmers. The amount of new land acquired by such owners is clearly greater than the quantity that was surrendered or forfeited by them. It can also be seen that a large part (approximately 33 percent) of the newly acquired property was owned by private non-farm individuals in 1930. At the same time, a large share of the land areas had not provided any tax revenues in 1936 (Fig. 11). Thus, it can be concluded that the agricultural land which was available in the 1930's, but which was not purchased to any great degree, had, during the 1940's, made the transition to farm ownership. Since these new acquisitions were not exactly prime agricultural areas, it is probable that the purchases were made to utilize the land for its timber and pulp wood value (refer to Fig. 5). The latter, as well as increasing mechanization, led more farmers to buy land which was not contiguous to their farmstead. While only six farmers owned such land areas in 1930 (Fig. 7), there were sixteen such cases in 1950 (Fig. 13). Finally, the poorer quality tracts which were owned by companies during 1930 and 1940 took their place on the tax forfeited property roles in the 1940's (compare Figs. 5 and 7).

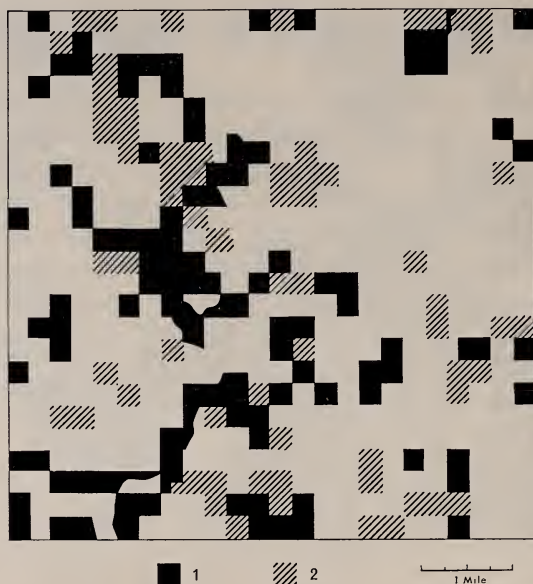


Fig. 14. Changes in land owned by farmers: 1930 to 1950.

1. New land acquired by farmers.

2. Land surrendered by farmers.

Source: Assessment Books of Taxable Real Property for Carlton County, 1930. Property Record and Appraisal Cards for Carlton County, 1950.

2. CATTLE

The total number of cattle decreased by 17.6 percent during the ten year interval (Appendix I). The main reason for the drop was a decline in the rather exceptional number of young stock which were evident in 1940. At the same time, however, dairy cows declined by only 5.1 percent, a considerably smaller loss than the 22.5 percent decrease exhibited by all of northeastern Minnesota (U.S. Bureau of the Census 1952).

When the various herds are grouped into size categories, no great variations between 1940 and 1950 are to be seen (Appendix III). Somewhat surprisingly, however, the number of small farms (1—5 cows) increased from two to twelve while the next category (6—10 cows) declined by two. Equally interesting is the fact that the larger farms (over 10 cows) decreased both absolutely and relatively. Therefore, the average number of cattle per farm declined from 15.2 to 14.2 animals. (Two farms had only calves and no older animals).

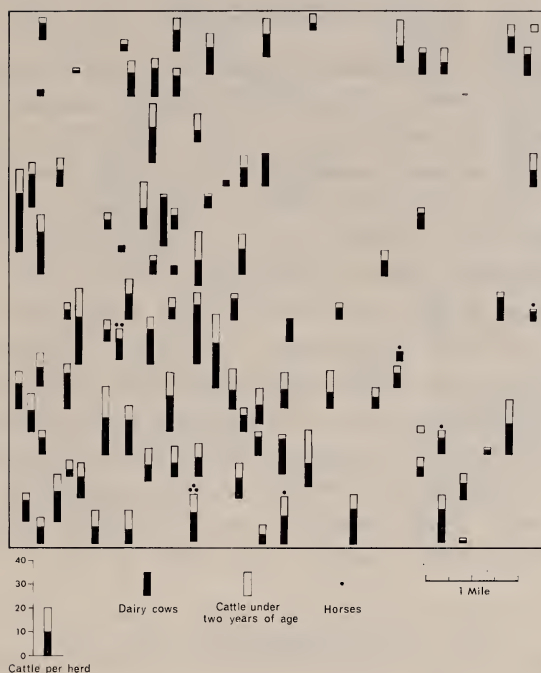


Fig. 15. Size of herds and number of horses by individual farm: 1950.
Source: Assessment Books of Personal Property for Carlton County, 1950.

The number of dairy cows also experienced about the same changes in the 1940 to 1950 interim (Appendix III). An increase in the number of herds with one to five dairy cows is evident along with a commensurate decline in the six to ten cow category. However, the proportion of herds in the township having more than ten cows increased somewhat; therefore, the average dairy herd grew slightly (8.7 cows to 8.9 cows). In spite of the fact that the total number of dairy cows decreased by 5.1 percent, the amount of milk produced in Kalevala Township probably did not decline since production per cow in Minnesota began to increase during the 1940's (State-Federal Crop and Livestock Reporting Service 1949).

As before, no clear correlation exists between farm acreage and the number of cows (Appendix III). Also, the different sized farms are not concentrated in any particular area of the township (Fig. 15).

3. MECHANIZATION

The conversion to mechanical horse power was almost fully completed during the 1940's. This can be seen especially in the continuing decline in the number of horses. By 1950 there were only fifteen such draft animals remaining in Kalevala Township (refer to Appendix I) with seventy-six farms having none at all. While the number of horses was shrinking, the tax values of tractors and other agricultural equipment grew rapidly from year to year. (The values, however, because of tax requirements and evaluations by different assessors, are not fully comparable over time). The rapid increase in the adoption of new technologic innovations corresponds with the development seen in southeastern Minnesota at the same time (McDaniel and Pond 1953, pp. 5, 14). Nevertheless, the mechanization of agriculture, in a relative sense, proceeded most rapidly in the northern areas of the state even though it was the sector which was least mechanized during 1940 (Ramsey *et al.* 1954, p. 12).

4. SUMMARY

Although Kalevala Township's population dropped by one-fourth and the farms declined by ten percent during the decade, the general structure of agriculture underwent few changes. This is illustrated by the fact that the »average farm» of 1950 differed very little from the one of 1940. At the same time, however, the moderate differentiation which had begun in the 1930 to 1940 interim continued into the following decade. One of the most noticeable facets of this process was the expanded proportion of small and large dairy herds and the decline in the middle sized units.

VI. CHANGES DURING THE PERIOD FROM 1950—1960

Rural townships situated more than twenty miles from Duluth continued to lose population during the 1950's (Rikkinen 1968 b, p. 323). The same was true of Kalevala Township which, with a twenty percent decline in population, fell to the same level reached in the 1900 to 1910 interval (Fig. 6).

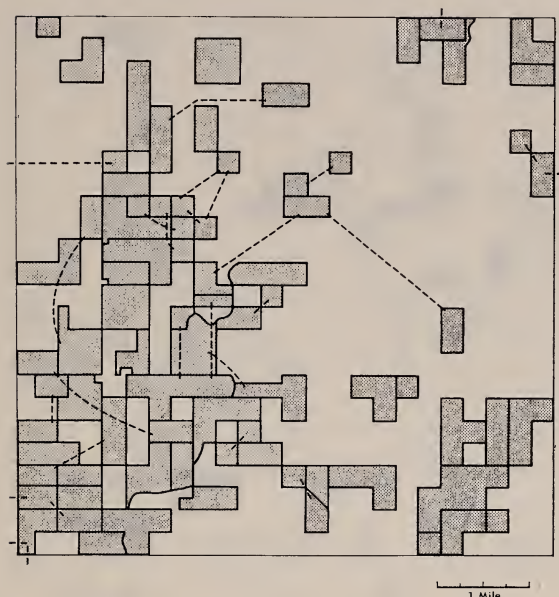


Fig. 16. Land owned by farmers: 1960. Non-contiguous land areas owned by the same farmer are joined by dashed lines.

Source: Property Record and Appraisal Cards for Carlton County, 1960.

1. NUMBER AND SIZE OF FARMS

Only fifty-nine farms remained in Kalevala Township by 1960 as compared to the ninety-four which had existed in 1950. The decrease (37.2 percent) was less than for northeastern Minnesota (43.2 percent) but greater than for the entire state (1950—1959: 18.6 percent) (U.S. Bureau of the Census 1952 and 1967). In addition, a rather sharp loss was exhibited in farm acreage with the total dropping from 9,840 to 7,320 acres. The loss, however, was not completely commensurate with the diminution in total farm numbers; therefore, the average farm size rose from 108 to 133 acres. In spite of the increase the typical Kalevala Township farm still remained below the average Minnesota farm of 211.4 acres in 1959 (U.S. Bureau of the Census 1967). As a group, the small farms in the township decreased both absolutely and relatively (Appendix II).

The difference in land owned by farmers in 1950 and 1960 reflects the drop in the total number of farms. The amount of such land which was released from ownership is clearly greater than the amount



Fig. 17. Changes in land owned by farmers: 1950 to 1960.

1. New land acquired by farmers.
2. Land surrendered by farmers.

Source: Property Record and Appraisal Cards for Carlton County, 1950 and 1960.

purchased (Fig. 17). While land which passed out of farm ownership is scattered throughout the township, the newly purchased areas are concentrated in the two sectors where the largest herds are located (Fig. 19).

By using property records and appraisal cards it has been possible to note year by year land sales from 1950 onward. The accompanying map (Fig. 18) illustrates those changes from 1950 to 1960 as they occurred on the farms which still existed as agricultural units in the latter year. It can also be seen that eight new farms began operating during the period. At the same time, seventeen farmers bought more land with almost one-half of the area being purchased from owners who still farmed in 1950 but terminated their operation sometime during the ensuing decade. Only two of the farms which still existed in 1960 had sold land sometime during the ten previous years. However, both of the farmers purchased additional land elsewhere in the township.

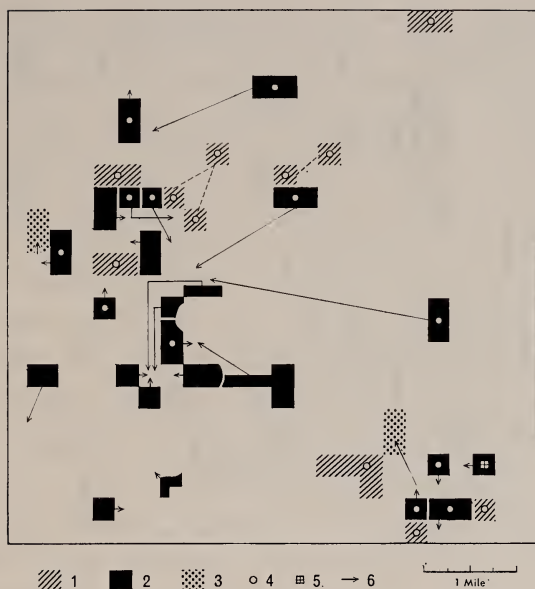


Fig. 18. Changes in land ownership from 1950 to 1960 for farms existing in 1960.

1. Newly formed farm.
2. Additional land acquired.
3. Land sold by farmers.
4. Land owned by non-farm, private owner in 1950.
5. Land owned by the county or state in 1950.
6. Direction of non-homesteaded property acquisitions.

Source: Property Record and Appraisal Cards for Carlton County, 1950—1960.

Generally speaking the farmers acquired their additional land from neighboring tracts. This was done not only to rationalize the farmer's total land holdings but also to secure the greatest possible advantage from certain tax regulations. For instance, taxes on property which adjoins the owner's place of residence (homestead) are lower in Minnesota while the levies placed upon non-contiguous property (non-homestead) are greater (State of Minnesota 1965, pp. 36—37). Nevertheless, some farmers bought land which did not border their farmstead. Therefore, it is apparent that in the 1950's distance did not offer the same limitations as before.

2. CATTLE

The total number of cattle in Kalevala Township dropped from 1304 in 1950 to 911 in 1960—a decrease of thirty percent. Relatively,

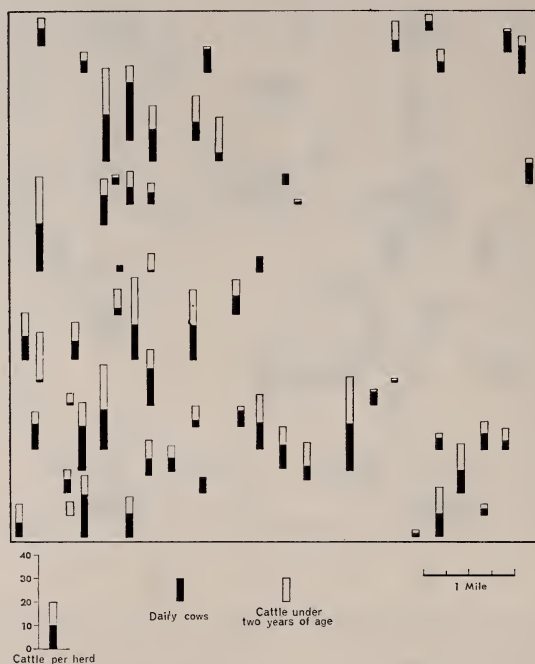


Fig. 19. Size of herds by individual farm: 1960.

Source: Assessment Books of Personal Property for Carlton County, 1960.

this was a greater loss than the decline of 17.6 percent experienced throughout northeastern Minnesota from 1950 to 1959 (U.S. Bureau of the Census 1952 and 1967). The major reason for the reduction in Kalevala Township was the diminishing number of older cattle, or those over three years of age (1950: 601—1960: 223) (Appendix I). Since the proportion of two to three year old dairy cows increased, it is apparent that the farms which terminated their operation sometime during the decade had a large number of older cows. With such a culling process the quality of the herds in Kalevala Township most certainly experienced an increase.

There was a rise in the relative proportion of larger herds (over twenty cattle) during the decade, and both an absolute and relative reduction in the number of small herds (Appendix III). Nevertheless, it is still apparent that some very small farms remained.

When dairy cows are considered, only the number of large herds (over fifteen cows) increased absolutely (Appendix III). A relative

decrease occurred in the percentage of middle sized herds or those having from six to fifteen cows. At the same time, however, it is somewhat surprising to note that the relative proportion of small herds (one to five cows) increased from 28.7 percent in 1950 to 37.3 percent in 1960. Because of this the size of the average dairy herd remained at a rather low 8.3 cows. These very smallest farms were often kept to provide for individual family needs and furnish some regular, albeit moderate, supplementary income. In many instances the owners of these herds were semi-retired persons who, out of the force of habit, were unable to completely sever their agricultural ties, even if the economic return for their efforts was meager. In other instances the relative increase in small herds depicts the rise in part-time farming. Even though off-the-farm work opportunities were not as great in Kalevala as in other suburban townships, commuting to such centers as Kettle River, Moose Lake and Cloquet, (see Fig. 2) did occur. While the head of the household went to work for the electrical power company, the paper mill, the highway department or some such employer, the size of the dairy herd quite naturally declined. However, a small herd was often retained with the wife and children usually doing many of the daily chores.

The predominance of dairying is illustrated by the fact that only one livestock herd in the township contained no dairy cows. Finally, by viewing Fig. 19 it can be seen that the biggest farms are located in the areas of densest settlement.

3. SUMMARY

The most remarkable occurrence to be noticed in Kalevala Township during the 1950's is the nearly one-third reduction in the number of farms. Hence, much of the land reverted to nonfarm ownership. On the other hand, many of the remaining farms added to their former holdings. Increasing mechanization made it possible to farm a greater and even more distant area, as illustrated by the purchase of non-homesteaded property. By the mid-1950's agricultural mechanization had reached such a point that no more horses remained in Kalevala Township (Appendix I).

An increase in specialization is also noticeable since only a few large farms produced the greatest part of Kalevala's total milk out-

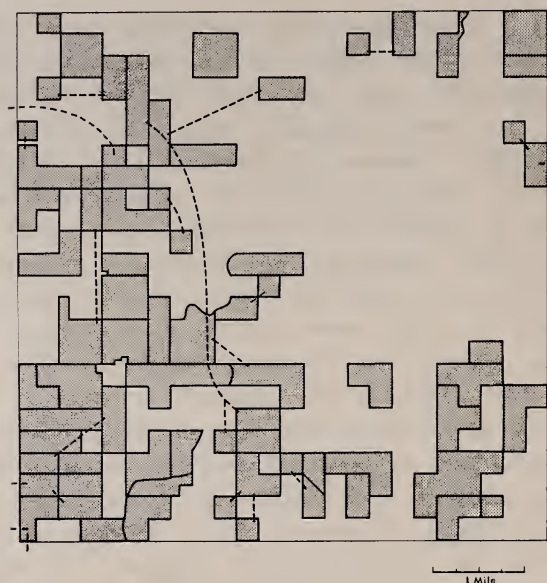


Fig. 20. Land owned by farmers: 1966. Non-contiguous land areas owned by the same farmer are joined by dashed lines.

Source: Property Record and Appraisal Cards for Carlton County, 1966.

put. These commercial farms also kept large numbers of young stock. Nevertheless, a fairly large group of semi-retired and part-time farmers still retained small herds in the township.

VII. CHANGES DURING THE PERIOD FROM 1960—1966

1. NUMBER AND SIZE OF FARMS

During the six year period from 1960 to 1966 the number of farms in Kalevala Township dropped by three to a total of fifty-six. A small change in the amount of land owned by farmers is also evident with the total increasing from 7,320 to 7,760 acres. The average farm grew from 133 to 146 acres with the proportion of small holdings (forty to eighty acres) decreasing and the larger units increasing (Appendix II). The trends are similar to those revealed in the 1959 and 1964 agricultural census figures (U.S. Bureau of the Census 1967) for both the Cutover area and Minnesota as a whole.



Fig. 21. Changes in land owned by farmers: 1960 to 1966.

1. New land acquired by farmers.

2. Land surrendered by farmers.

Source: Property Record and Appraisal Cards for Carlton County, 1960 and 1966.

The amount of new land purchased by farmers in the six year period is greater than the total acquired from 1950 to 1960. At the same time the amount of land released from farm ownership was much greater in the 1950's (compare Figs. 17 and 21). The 1960 to 1966 changes in land ownership, as represented by those units still engaged in farming during 1966, are to be seen in Figs. 20 and 22.

A total of eleven new farms were established during the period. Except for one such entity, the new farms were started in areas which were not farmed in 1960. The largest part of the total area of these farms was taken from the significant pool of land which had been released from production during the 1950's. It can also be seen from the maps that ten farms increased their holdings from 1960 to 1966. The new land for these farms was also acquired from individual property owners not engaged in farming as well as from tax forfeited county holdings. Except for two cases the farmers bought land adjacent to their former acreage (i.e., homesteaded property).

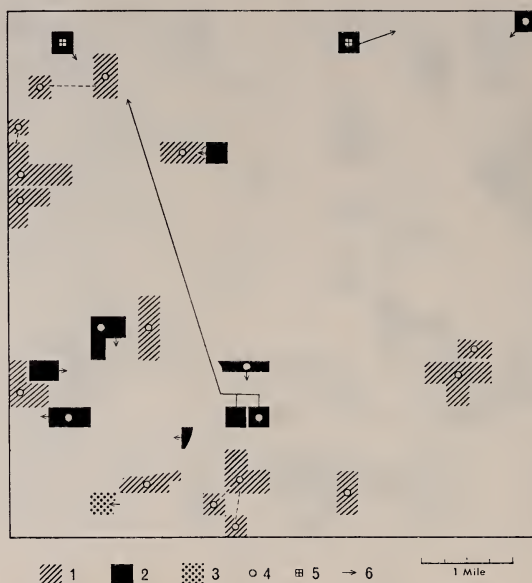


Fig. 22. Changes in land ownership from 1960 to 1966 for farms existing in 1966.

1. Newly formed farm.
2. Additional land acquired.
3. Land sold by farmers.
4. Land owned by non-farm, private owner in 1950.
5. Land owned by non-farm, private owner in 1950.
6. Direction of non-homesteaded property acquisitions.

Source: Property Record and Appraisal Cards for Carlton County, 1960—1966.

2. CATTLE

As revealed by tax figures, the farmers in Kalevala Township derived the vast majority of their income from dairying up to 1960. While the 1951 tax books revealed the first farm to keep beef cattle (Appendix I), only sporadic attempts to raise meat animals were made during the remainder of the decade. However, the raising of beef cattle and feeders began during the 1960's and the number rapidly reached significant proportions. In fact, by 1966 beef cattle were present in such numbers that there was more than one beef cow for every three dairy animals. It is obvious that a new form of agricultural endeavor began to emerge during the six year interval.

The number of dairy cows and cattle under two years of age remained about the same as at the beginning of the decade. The total number of cattle rose from 911 to 998 because of the increase

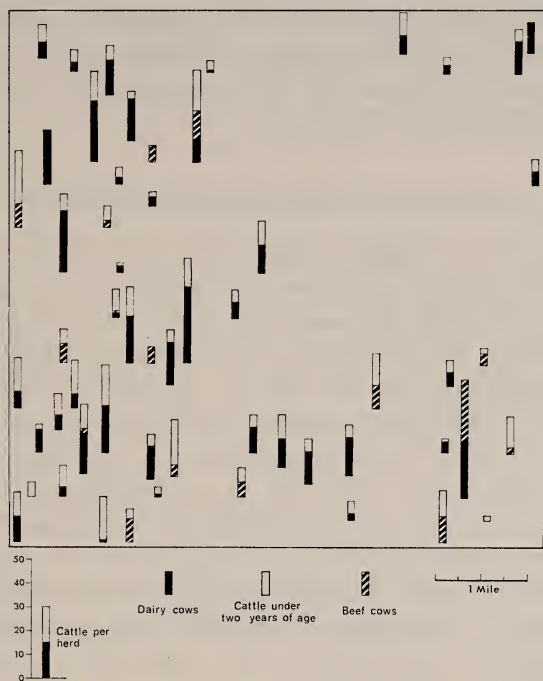


Fig. 23. Size of herds by individual farm: 1966.

Source: Assessment Books of Personal Property of Carlton County, 1966.

in beef cattle. The developments which have taken place in the 1960's are clearly depicted by the emergence of three farm types (compare to Fig. 23):

Dairy farms	38
Beef farms	14
Mixed farms	4
Total	56

The small number of mixed farms indicates that specialization had now developed.

The number of dairy farms decreased during the six year interval from fifty-eight to forty-two. The majority of the loss was due to small farms going out of existence (Appendix III). With the relative proportion of large herds growing, the average dairy farm in 1966 had 11.0 cows as compared to 8.3 in 1960. Thus, the movement to larger herd size which has been evident throughout the report, is also to be seen in the most recent years. Although the total number

of herds is smaller, the larger units with improved quality and a more efficient operation, actually produce a greater amount of milk than before. This same trend can also be seen throughout the entire nation (University of Minnesota 1963, p. 6).

3. MECHANIZATION AND SPECIALIZATION

Generally, and as indicated earlier, the tax value of property can not be compared from year to year. In spite of this, individual farms can be compared during the same year since only one assessor is used for each township. If nothing else, the increasing significance of large agricultural machinery can be seen by viewing the tax figures.

The positive relationship between the type of farm, the number of cattle and the level of mechanization is to be seen in the accompanying scatter diagrams (Fig. 24). As a measure of mechanization, the »true and full value» of the equipment employed by the farmer in his own agricultural pursuits has been used.¹ A large portion of the farms have less than twenty-five cattle and an equipment value under 400 dollars. In this group of smaller farms no significant correlation exists between the size of herds and level of mechanization.² Within the small group of larger farms (more than 25 cattle) there is evidence of higher equipment values. All of the farms with an equipment value in excess of 500 dollars are dairy or mixed farms. This is largely because of recent large investments which have become more commonplace in the dairy industry. The biggest expenditure for the individual operator involves the purchase of a bulk tank milk cooler, something which only the largest farms have been able to acquire to the present date.

Thus, the above-mentioned specialization is even emphasized more so when the level of mechanization is considered. Farms with bulk tanks are able to sell »Grade-A» milk and thereby receive a higher price for their product while those with older less efficient cooling

¹ »True and full value» is about 33.3 percent of the market value. However, because of amortization, which reduces the value of equipment progressively over time, the absolute figures should not be regarded as representing the true face value of the farmer's holdings. The figures are most useful in providing indices for relative comparisons.

² The linear correlation ($r = .086$) between mechanization and herd size was not statistically significant at any level for the group of farms with an equipment value less than 400 dollars and fewer than twenty-five cattle.

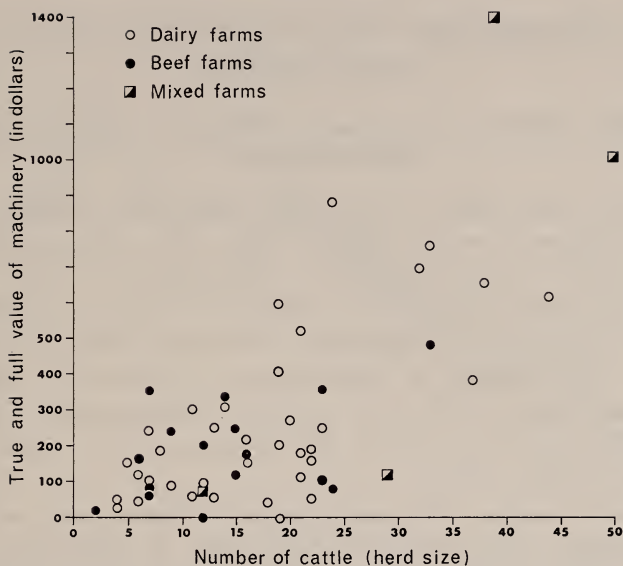


Fig. 24. Relationship between the type of farm, the number of cattle and the level of mechanization: 1966.

Source: Assessment Books of Personal Property for Carlton County, 1966.

systems have to sell lower priced »Grade-B» milk. The majority of the Grade A milk is brought to Duluth whereas the Grade B product is usually sold to small creameries in the immediate area of Kalevala (V. Niemi, interview).

3. SUMMARY

In spite of the small decline in the total number of farms during the six years, agriculture in Kalevala Township has become much more specialized. During the last three years of the period under study, the raising of beef cattle has begun to challenge the dominance of dairying. As a rule, the majority of farms in the township specialize in either one of the operations.

The maintenance of a beef herd requires less labor and equipment than a dairy herd. At the same time, the dairy herds generally fall into two groups. The majority of the farms are still the traditional small or middle sized dairy operation which does not contain specialized equipment such as a bulk tank. While receiving a higher price for their milk, about one-third of the dairy farms have large herds and new bulk tank cooling systems.

VIII. COMPARISONS WITH THE MACRO SCALE AND CONCLUSIONS

1. GENERAL TRENDS IN KALEVALA TOWNSHIP, THE CUTOVER AREA AND MINNESOTA

For every time period in this study, Kalevala Township has been compared to larger areas of measure. Also, every time period has been described with a partial summary. Nevertheless, it is still necessary to offer an over-all summary and thereby reveal the general setting of Kalevala Township in Minnesota's changing picture of agricultural geography.¹ The changes in Kalevala are compared to those in the Cutover area (Fig. 1) and to the entirety of Minnesota. To illustrate the occurrences, trend lines (Figs. 25—28) derived from index numbers, will be used (1930 = 100).

The lines indicating the total number of farms and average farm size in Minnesota are quite consistent (Figs. 25 and 26). Since the 1940's the number of farms has decreased and the size of the farm has grown rather remarkably. The trends in northeastern Minnesota are characterized by noticeable »waves». Waves of short term shifts in the Kalevala trend is most likely the result of the detailed nature of the data in the sample, whereas the data for Minnesota and the Cutover area are such that small shifts are obliterated. During the difficult times of the 1930's the number of farms increased while the average size decreased. Since World War II the total number of farms has fallen and the average farm size has risen even more rapidly than for all of Minnesota. In describing this marginal agriculture area it has also been appropriately stated that the Cutover »acts as a sponge, absorbing population in bad times, and releasing it in good times» (Nelson 1960, p. 24). In the older and established areas of southern Minnesota the development of agriculture has proceeded steadily (refer to Nelson and Khan 1956, pp. 1—7), and the influence of these densely settled regions is strongly reflected in the over-all trends for Minnesota. The diagrams clearly show that in terms of

¹ As was mentioned before, Professor Stig Jaatinen is preparing a study relating to rural area development in the entire Cutover area (also including northern Wisconsin and Michigan). In his study the differences within the Cutover area will be more evident and it will then be possible to determine to what extent the occurrences in Kalevala can be used to describe the general area.

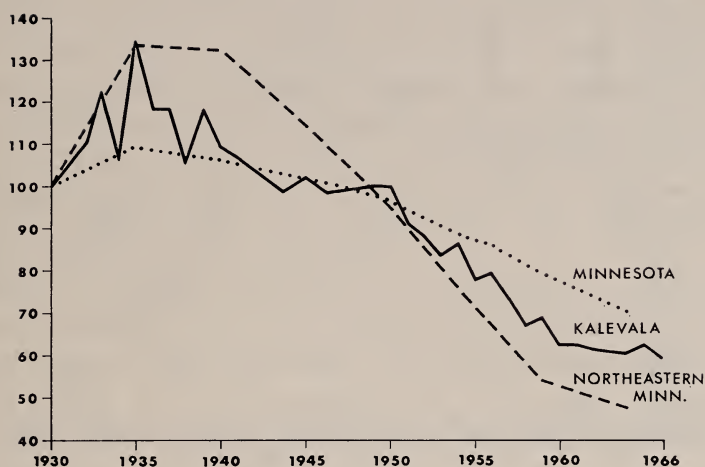


Fig. 25. Trends exhibited in the number of farms in Kalevala Township, North-eastern Minnesota and Minnesota: 1930—1966 (1930 = 100).

Source: U.S. Bureau of the Census 1932, 1942, 1952, 1956 and 1967. Assessment Books of Personal Property for Carlton County, 1930—1966.

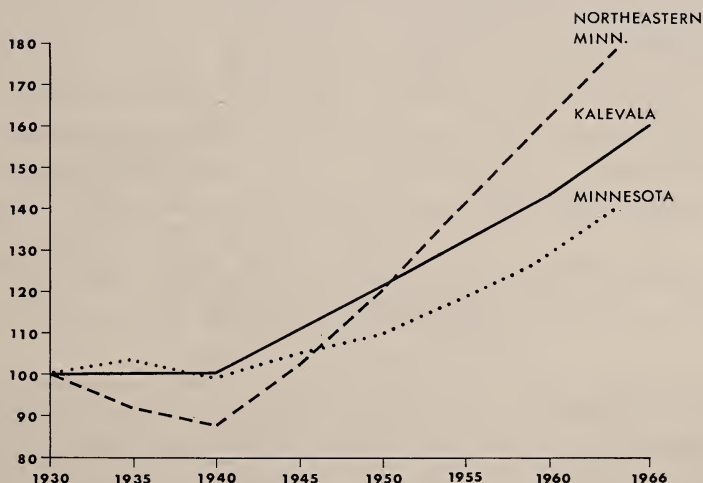


Fig. 26. Trends exhibited in the average size of farms in Kalevala Township, Northeastern Minnesota and Minnesota: 1930—1966 (1930 = 100).

Source: U.S. Bureau of the Census 1932, 1942, 1952, 1956 and 1967. Assessment Books of Taxable Real Property for Carlton County, 1930 and 1940. Property Record and Appraisal Cards for Carlton County, 1950, 1960 and 1966.

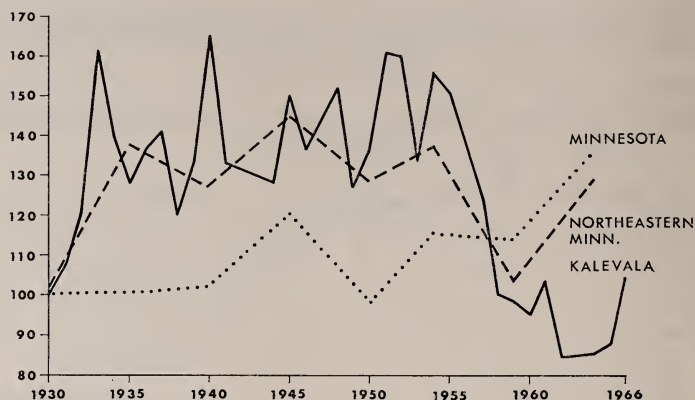


Fig. 27. Trends exhibited in the total number of cattle in Kalevala Township, Northeastern Minnesota and Minnesota: 1930—1966 (1930 = 100).
Source: Same as in Fig. 25.

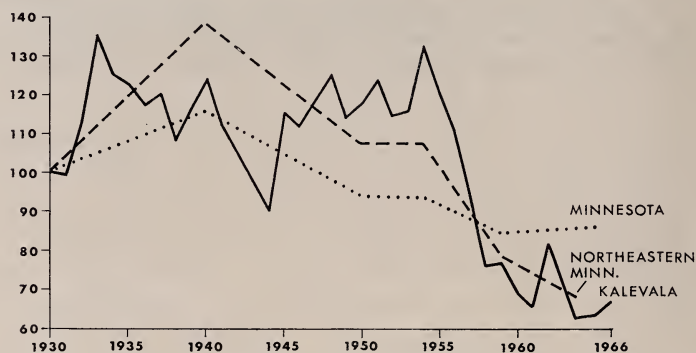


Fig. 28. Trends exhibited in the number of dairy cows in Kalevala Township, Northeastern Minnesota and Minnesota: 1930—1966 (1930 = 100).
Source: Same as in Fig. 25.

total farm numbers and in average acreage, Kalevala is located between the trends exhibited by northeastern Minnesota and the entire state.

The trends exhibited in Kalevala, considering both the total number of cattle and dairy cows, mirror one another almost entirely (Figs. 27 and 28). This is understandable since the farms throughout most of the study period have mainly been dairy operations. In terms of total cattle, the trends in Kalevala Township and northeastern Minnesota follow one another up to the end of the 1950's, but break away thereafter. This is because the raising of beef cattle began

about three or four years earlier in the northeastern sector of the state than in Kalevala. One of the major reasons for the delay appears to be that the production of milk, in spite of a dairy surplus (refer to Learn *et al.* 1962, pp. 25—26), remained more feasible in Kalevala than throughout much of the Cutover. This is more apparent when Kalevala's relative position within the Duluth milkshed is considered. Throughout the study period the change in the total number of cows in both the Cutover area and Kalevala has been noticeably larger than the average for all of Minnesota.¹

Making a meaningful comparison of mechanization is more difficult since the tax books do not, for example, give the number of tractors, but only list the adjusted values of machinery and equipment. The values, in turn, are not comparable year after year. In one other study it has been revealed that mechanization began later in Northeast Minnesota than in the southern part of the state; however, once the process began it proceeded more rapidly in the former area (Ramsay *et al.* 1954, p. 12). During 1954, the last agricultural census year in which the number of horses is listed, there still were 9,777 such animals in northeastern Minnesota — some 25.3 percent of the 1930 total. Meanwhile, in Kalevala not one horse was to be found by 1954 (Appendix I). It can thereby be concluded that mechanization occurred more rapidly in Kalevala than in northeastern Minnesota.

As a whole, the general trends which have been evident in Kalevala Township throughout the study period fall between those of the Cutover area of Minnesota and the entire state. In other words, and as might be expected by viewing the map, Kalevala is located in a transition zone between the two areas.

2. A COMPARISON OF RECENT CHANGES IN KALEVALA TO ONE INCOME-MAXIMIZING STUDY

It is interesting to compare the situation in Kalevala to a study concerning certain adjustments which farmers in the Lake States Dairy Region might make to realize greater profits (University of Minnesota 1963). The study was based upon an income-maximizing linear programming analysis of the typical farms in Minnesota, Wisconsin and

¹ It is difficult to compare the number of cows in Kalevala to the macro scale before 1950 since the 1935 and 1945 agricultural census figures did not list milk cows separately.

Michigan. The demand for manufactured milk products was projected to increase by 5.5 percent from 1959 to 1965. For the farmers this equilibrium analysis indicated that three income improving adjustments would be of major importance (*op. cit.*, pp. 4—5 and 38—39): 1) Grade A producers could generally provide an increased supply of milk as their competitive position in dairying is strong when compared to the Grade B producers. 2) Many Grade B dairy farmers would find it profitable to decrease or eliminate their dairy enterprise and increase beef and hog feeding. 3) An increase in cow quality and herd size would improve incomes on those farms staying in dairy production.

The listed proposals, which appear to offer hope for a certain number of farmers, are emerging in Kalevala. Nevertheless, the first two points have just begun to appear in the 1960—1966 period—the last period of this study.

3. FINAL STATEMENT

At the beginning of this study it was stated that general trends in agricultural geography, which are held to be more or less universal, are usually revealed on the macro scale. These trends generally depict the hypothetical »average farm». Since a relatively static situation prevailed in agriculture prior to 1930, the average farm up to that date corresponded quite closely to any farm which might be studied on the micro scale. However, and as was illustrated especially for the latter years of this study, farm differentiation, later followed by specialization, has begun to appear. The changes have occurred so rapidly from year to year that the so-called average farm now corresponds even less to the actual conditions in the field. In practice, the true picture can only be seen by viewing the situation in micro scale. At this level some variation in response to national economic processes and pressures often occurs as the result of local factors. In Kalevala, such factors as location relative to Duluth, the ethnic composition of the population, and local physical conditions contribute to its transitional nature and its variation from state and regional norms. Hence, the doubt expressed by two Minnesota geographers at the beginning of this study that »the process of change on the landscape or micro scale may be lost in generalization» (Kaups and Mather 1967, p. 57), certainly appears to be justifiable.

REFERENCES

- Allison, J. H. and Cunningham, R. N. (1963). Timber farming in the Cloquet district. *University of Minnesota, Agricultural Experiment Station, Bulletin* 343, 1—35.
- Baker, Donald G., Haines, Donald A. and Strub, Joseph H., Jr. (1967). Climate of Minnesota. Part V. Precipitation facts, normals, and extremes. *University of Minnesota, Agricultural Experiment Station, Technical Bulletin* 254, 1—44.
- Baker, Donald, G. and Strub, Joseph H., Jr. (1963 a). Climate of Minnesota. Part I. Probability of occurrence in the spring and fall of selected low temperatures. *University of Minnesota, Agricultural Experiment Station, Technical Bulletin* 243, 1—40.
- — (1963 b). Climate of Minnesota. Part II. The agricultural and minimum-temperature-free seasons. *University of Minnesota, Agricultural Experiment Station, Technical Bulletin* 245, 1—32.
- — (1965). Climate of Minnesota. Part III. Temperature and its application. *University of Minnesota, Agricultural Experiment Station, Technical Bulletin* 248, 1—64.
- Borchert, John R. (1958). *A reconnaissance atlas of Minnesota agriculture*. 25 p. University of Minnesota. Mimeo.
- Crickman, C. W., Sallee, George A. and Peters, W. H. (1934). Beef cattle production in Minnesota. *University of Minnesota, Agricultural Experiment Station, Bulletin* 301, 1—76.
- Cunningham, R. N., Horn, A. G. and Quinney, D. N. (1958). Minnesota's forest resources. *United States Department of Agriculture, Forest Resource Report* 13, 1—52.
- Dowell, Austin A. and Brekke, Arnold (1948). Trends in prices of purebred cattle. *University of Minnesota, Agricultural Experiment Station, Bulletin* 398, 1—19.
- Engene, Selmer A. and Pond, George A. (1940). Agricultural production and types of farming in Minnesota. *University of Minnesota, Agricultural Experiment Station, Bulletin* 347, 1—70.
- Fuguitt, Glen V. (1963). The city and countryside. *Rural Sociology* 28, 246—261.
- Hady, Frank T. and Engene, S. A. (1957). Distribution of grasslands in Minnesota. *University of Minnesota, Agricultural Experiment Station, Station Bulletin* 439, 1—27.
- Hansen, T. S., Allison, J. H., Brown, R. M., Cheyney, A. E. and Schmitz, Henry (1936). The Cloquet forest. A demonstration of practical forestry in northern Minnesota. *University of Minnesota, Agricultural Experiment Station, Technical Bulletin* 112, 1—84.

- Johnson, Hildegard Binger (1957). Rational and ecological aspects of the quarter section: an example from Minnesota. *Geographical Review* 47, 331—348.
- Kaups, Matti (1966). Finnish place names in Minnesota: a study in cultural transfer. *Geographical Review* 56, 377—397.
- Kaups, Matti and Mather, Cotton (1968). Eben: thirty years later in a Finnish community in the Upper Peninsula of Michigan. *Economic Geography* 44, 57—70.
- Knudtson, Arvid C. and Cox, Rex W. (1962). Upper Midwest agriculture: structure and problems. *Upper Midwest Economic Study, Study Paper* 3, 1—42.
- Koller, E. Fred and Jesness, O. B. (1940). Trends in the Minnesota dairy industry. *University of Minnesota, Agricultural Experiment Station, Bulletin* 346, 1—40.
- Learn, Elmer W., Cox, Rex W. and Herder, Richard J. (1962). Upper Midwest agriculture: alternatives for the future. *Upper Midwest Economic Study, Study Paper* 6, 1—64.
- McDaniel, W. E. and Pond, G. A. (1953). Changes in the dairy farming picture. *University of Minnesota, Agricultural Experiment Station, Bulletin* 416, 1—20.
- Mighell, Ronald L. and Black, John D. (1951). *Interregional competition in agriculture with special reference to dairy farming in the Lake States and New England*. 320 p. Cambridge, Mass.
- Nelson, Lowry (1960). *The Minnesota community, country and town in transition*. 175 p. Minneapolis.
- Nelson, Lowry and Clappitt, Hazel (1945). Population trends in Minnesota, 1940. *University of Minnesota, Agricultural Experiment Station, Bulletin* 387, 1—39.
- Nelson, Lowry and Khan, A. Majeed (1956). *Some characteristics of farm life in Minnesota's northern forested area*. 13 p. University of Minnesota, Agricultural Experiment Station. A preliminary report. Mimeo.
- Pond, George A. and Crickman, C. W. (1933). Planning farm organizations for the northeast cut-over section of Minnesota. *University of Minnesota, Agricultural Experiment Station, Bulletin* 295, 1—104.
- Ramsey, Charles E., Orman, Allan D. and Nelson, Lowry (1954). Migration in Minnesota, 1940—50. *University of Minnesota, Agricultural Experiment Station, Bulletin* 422, 1—16.
- Rikkinen, Kalevi (1968 a). Population changes in the incorporated hamlets of Minnesota, 1930—1940. *Acta Geographica* 19: 4, 1—31.
- » — (1968 b). Change in village and rural population with distance from Duluth. *Economic Geography* 44, 312—325.
- Sandberg, Lynn, Horn, G. Arthur and Guilkey, Paul C. (1950). *The forest resource of Carlton county*. Published by the Office of Iron Range Resources and Rehabilitation. 50 p. St. Paul.
- Schantz-Hansen, T. and Jensen, Raymond A. (1956). 40 years of weather at the Cloquet experimental forest. *University of Minnesota, Agricultural Experiment Station, Bulletin* 436, 1—20.
- State-Federal Crop and Livestock Reporting Service (1949). *Minnesota agricultural statistics*. 45 p. St. Paul.

- State of Minnesota, Department of Taxation (1935). *Minnesota assessor's manual with laws governing assessor's duties*. 146 p. St. Paul.
- University of Minnesota (1963). Equilibrium analysis of income improving adjustments on farms in the Lake States dairy region, 1965. *Acricultural Experiment Station, Technical Bulletin* 246, 1—54.
- U. S. Bureau of the Census (1931). *U. S. census of population: 1930*, Vol. I. Washington D. C.
- » — (1932). *U. S. census of agriculture: 1930*, Vol. II, Part 1. Washington D. C.
- » — (1942). *U. S. census of agriculture: 1940*, Vol. I, Part 2. Washington D. C.
- » — (1943). *U. S. census of population: 1940*, Vol. II, Part 4, Washington D. C.
- » — (1952). *U. S. census of agriculture: 1950*, Vol. I, Part 8. Washington D. C.
- » — (1956). *U. S. census of agriculture: 1954*, Vol. I, Part 8. Washington D. C.
- » — (1963). *U. S. census of population: 1960*, Vol. I, Part 25. Washington D. C.
- » — (1967). *U. S. census of agriculture 1964*, Vol. I, Part 15. Washington D. C.
- Wasastjerna, Hans R. (1957). *Minnesotan suomalaisten historia*. 780 p. Superior, Wis.

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Appendix I.

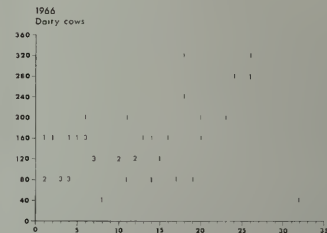
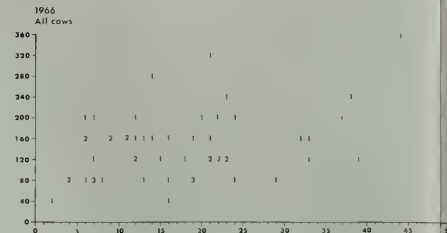
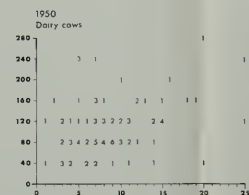
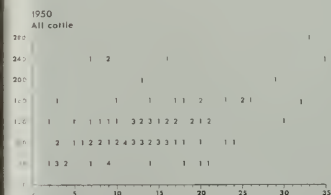
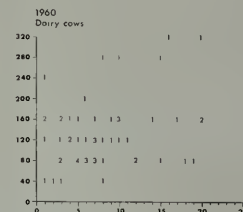
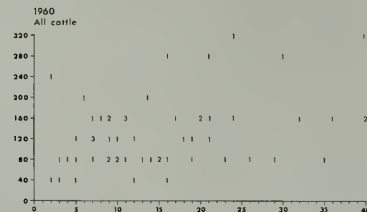
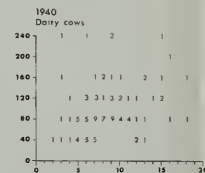
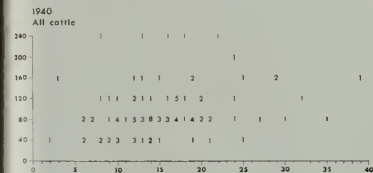
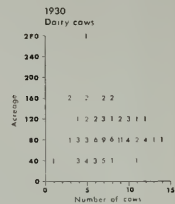
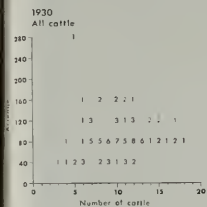
Selected agricultural data for Kalevala Township: 1930—1966. Source: Assessment Books of Personal Property for Carlton County, 1930—1966.

Year	Horses	Cattle under 1 year	Cattle 1—2 years	Dairy cows		Sires	Beef cows	Feeders	Total number of cattle	Total number of farms
				2—3 years	over 3 years					
1930	143	75	158	167	528	29	—	—	957	94
1931	140	152	150	165	538	28	—	—	1,033	99
1932	147	164	161	202	582	46	—	—	1,155	103
1933	143	347	209	218	723	46	—	—	1,543	115
1934	150	249	171	220	649	48	—	—	1,337	100
1935	150	186	162	191	662	26	—	—	1,227	126
1936	140	278	184	157	662	49	—	—	1,307	111
1937	131	285	185	194	644	41	—	—	1,349	111
1938	128	227	136	171	581	34	—	—	1,149	90
1939	119	261	156	194	617	43	—	—	1,271	111
1940	96	457	203	198	665	59	—	—	1,582	103
1941	83	242	217	174	605	36	—	—	1,274	100
1942	No data									
1943	No data									
1944	58	226	346	232	397	29	—	—	1,230	93
1945	62	292	287	332	471	50	—	—	1,432	96
1946	48	202	268	299	481	57	—	—	1,307	93
1947	No data									
1948	48	299	231	226	644	53	—	—	1,453	97
1949	35	170	242	244	551	10	—	—	1,217	94
1950	15	247	228	218	601	10	—	—	1,304	94
1951	16	405	261	245	617	4	8	—	1,540	86
1952	18	481	216	230	568	27	8	—	1,530	83
1953	8	197	276	258	549	5	—	—	1,285	79
1954	—	307	249	292	630	10	—	—	1,488	81
1955	4	278	309	419	417	9	11	—	1,443	73
1956	3	248	284	380	389	—	13	—	1,314	75
1957	1	221	284	341	318	—	26	—	1,190	69
1958	—	183	247	287	242	—	—	—	959	63
1959	—	199	209	280	254	—	1	—	943	65
1960	—	231	200	257	223	—	—	—	911	59
1961	—	296	240	247	208	2	1	—	994	59
1962	—	60	169	146	421	9	2	1	808	58
1963	No data									
1964	—	9	256	436		1	34	80	816	57
1965	—	24	279	444		3	44	47	841	59
1966	—	203	200	464		5	100	26	998	56

Appendix II.

The distribution of farms in Kalevala Township during 1930—1966 by major acreage groupings. Source: Assessment Books of Taxable Real Property, 1930—1966.

Acreage	1930		1940		1950		1960		1966	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
40	18	19.1	20	19.4	15	16.0	4	6.8	2	3.6
80	51	54.3	49	47.6	34	36.2	18	30.5	14	25.0
120	16	17.0	18	17.5	25	26.6	13	22.0	11	19.6
160	8	8.5	10	9.7	12	12.8	16	27.1	14	25.0
200			1	1.0	2	2.1	2	3.4	7	12.5
240					5	5.3	1	1.7	1	1.8
280	1	1.1			1	1.1	3	5.1	2	3.6
320							2	3.4	2	3.6
360									1	1.8
No data			5	4.9						
Total	94	100	103	100	94	100	59	100	56	100



Relationship of individual farm acreage to number of cattle and dairy cows in Kalevala Township: 1930-1966.

Source: Assessment Books of Taxable Real Property for Carlton County, 1930 and 1940. Assessment Books of Personal Property for Carlton County, 1930, 1940, 1950, 1960 and 1966. Property Record and Appraisal Cards for Carlton County, 1950, 1960 and 1966.

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THE GROWTH HISTORY OF WORLD'S RAILWAY NET

BY
REINO AJO

HELSINKI 1969

Presented the 14th of March 1969
by Stig Jaatinen and Veikko Okko.

TO RISTO

The history of railways begins with that of the locomotive. Both have their entrance into public knowledge most conveniently timed in 1829, the year when the world's first practical locomotive showed its abilities in the Rain Hill, England, competition arranged for inventors who demonstrated their engines on a specially built test track.

The possibilities offered by the railways, particularly in the long distance transports, became for the spectators dramatically apparent. Everybody at once realized that the railways would occupy a position of natural supremacy over other forms of inland transport. This stimulating fact was met with as a psychological shock.

This input stimulus released a wide activity although concrete results did not instantly appear because the planning, difficult legal formalities, and, of course, the practical road building always require time. Additionally, the railway promoters had at every step to overcome unusual technical and economical asperities, all kinds of difficulties due to rivaling interests, ignorance, superstition etc.

On the other hand, one very soon realized that the railway construction was actually an injection of effective buying power which gave birth to new needs, new effective demand, new employment, and extraordinary chances for earning and speculating. Thus one was confronted with the multiplier effect. People constantly met new exitatory impulses which increased the pressure and speeded up the progress of railroading. In the 40's it had come into a vigorous state commonly known as the railway boom.

In the beginning boom the railways apparently had overcome the initial difficulties because the growth accelerated and continued almost linearly to a point of time, little before the turn of the century. This upstroke broadly coincides with Schumpeter's second, so-called coal era, or Kondratieff's third cycle (1848—1897), called forth by the railway boom.

After the said point of time, in this study fixed as y. 1896, the growth rate slackens and the phenomenon of saturation sets in; con-

currently, the net growth which is the visible response to actual excitation reaches gradually a limiting value which is not exceeded however large a stimulus there is. The saturation is complete in that point where the growth rate becomes equal to zero. This happens in 1963. The present study thus implies the time range of $1963 - 1829 = 134$ years.

In graphical representation the growth curve thus appears as a sigmoid (—/—) which consists of three characteristic parts, *viz.* the principal, quasi-rectilinear part (the stalk), and both terminal parts. A sigmoid like this corresponds with biologically typical evolution. As to its form, the growth curve is surprisingly regular, as we are going to see. How the growth curve might behave on the other side of the upper limit, excites one's curiosity. In the context, however, it doesn't occupy us.

Statistical variates

Considering a subject of this magnitude, the scale dimensions must be chosen accordingly. As a suitable unit for the line length we find thousand kilometres, and for time ten years, that is a decade. Plotting the time-dependent line length on time gives the growth curve which is in this study of primary importance although the first and second derivatives are also considered. Time is the independent variate whose zero is set at year 1829.

Statistical sources

In the early days of railways there was no agency to collect comprehensive statistics of world's railway mileage. Even the statistics of the International Union of Railways (UICF) is restricted to information concerning the member-companies. Because all companies are not members, the statistics is incomplete. For instance, it does not include American railways.

In space this kind of statistics is usually made to coincide with the *present* national boundaries which, however, are not permanent. Therefore it is necessary occasionally to adjust the data by assigning old statistics into new frames. This not only implies added possibilities to error, but it makes statistical compilations from different times

unlike. By reason of this, one must be on the alert in comparing statistics from different vintages.

The development of world's railway mileage is anyway shown in progressive ten-year periods in a table prepared under the direction of the Editor of »The Railway Gazette» (London). Its figures, collected for the years 1840(10)1960, indicate the cumulated mileage of public main-line railways in most of the countries throughout the world. Light railways, steam railways, and interurban electric lines are, however, excluded. In spite of this specifying, the given figures are not strictly correct by reason of divergencies in practice as to what constitute minor railways, light railways, and secondary lines.

The said figures are published in the »Railway Directory & Year-book» whose table: »Development of world's railway mileage» (1967, pp. 572—574) has served the present study as the most important statistical source. With due regard to divergencies just mentioned, all figures are critically inspected and compared with information got from other reliable sources, and necessary adjustments are made in connexion with a minor smoothing of the data. Thus is obtained Table 1.

Mathematical formulation of the growth history

For eliminating inconsistencies, the most reliable figures were chosen from the available statistical sources inspected for this purpose. Thus was obtained the column »Compiled Statistics» in Table 1. After inspection and graduation, this series was rewritten as the column »Adjusted Figures». From it are deduced the two last columns. Each column gives a time-series of observed values for a supposedly continuous function of time.

In Figure 1 the circles of observed y values stake out a typical growth curve. As an attempt to find a simple mathematical expression which would satisfactorily represent the growth function, trigonometric polynomial is fitted to the observed values. A polynomial of odd cosines is tried.

As a first approximation we let $y_1 = a_1 \cos(wt)$. By inspection we make $a_0 = 675$. The quarter-wave $L: 4 = (1896-1829) : 10 = 6.7$ dec. whence the circular frequency $w = \pi/2(6.7) = 0.234$ rad/dec. The amplitude a_1 is chosen to leave a remainder in the form of the second

Table 1. *Cumulated net line-length of world's main-line railways. Thousands of kilometres open at the end of ten-year periods.*

Due to lack of consistent definitions, there are divergences in practice as to what to include what not. For this reason the figures here given should be regarded only as approximate and perhaps not always strictly comparable (cf. Ry. Dir. 1967, p. 572; Ency.Brit. Vol. 18, pp. 916—917. See also text.

Last year of Decade	Compiled Statistics *	Adjusted Figures	Growth Rate	Incr. of Growth Rate
1840	8	8	8	8
50	38	34	26	18
60	106	92	58	32
70	205	197	105	47
80	359	354	157	52
90	581	552	198	41
1900	760	767	215	17
10	961	969	202	—13
20	1115	1133	164	—38
30	1245	1246	113	—51
40	1310	1310	64	—49
50	1345	1340	30	—34
60	1350	1350	10	—20

* *Sources:*

Years 1840—1920: Figures compiled from Ry.Dir. 1967—68, pp. 572—574. Years 1850 and 1914: 35 and 1081, resp., Lesourd—Gérard, p. 216.

1930: Ry.Dir.: 1210; IT: 1280, Vol. 10, pp. 1219—1220. Average = 1245.

1940: Interpolated figure.

1960: UT Vol. 16, Col. 829.

approximation, that is, to render $y - y_1 = a_2 \cos(3\omega t) + \varepsilon$. Inspection shows this to take place with $a_1 = -735$ and $a_2 = 60$. It also appears that no more approximation is required because the solid line in Figure 1 is the graph of the expression

$$y = 675 - 735 \cos(0.234t) + 60 \cos(0.702t) \quad (1)$$

This may be regarded as the equation representing the history of world's railway lines. Its fit to the observed values is manifestly good.

In Figure 1 the cosine components of y are shown dashed. Considering them, it is seen that the first approximation, y_1 , rather closely accompanies y in its course. The second approximation introduces a correction whose amplitude is only 1/12 of a_1 whereas its frequency is 3 times that of a_1 . The third approximation is nothing to speak of.

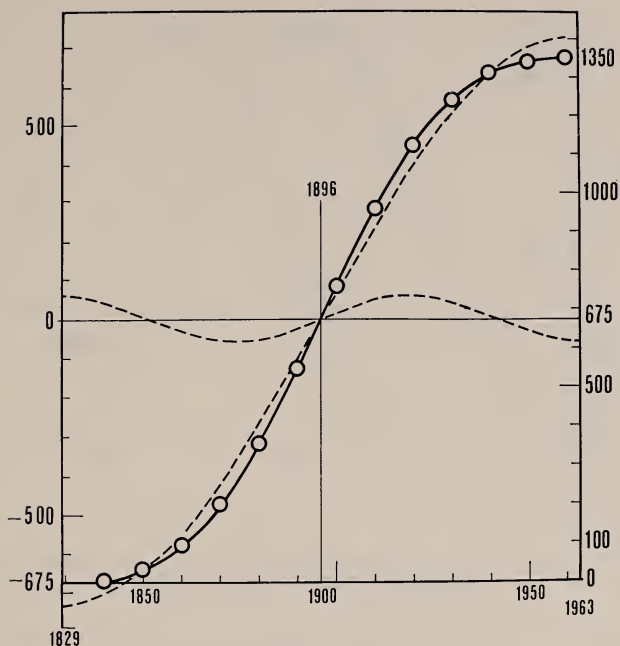


Fig. 1. The Growth Curve of world's railway lines (for legend, v. text).
 $y = 675 - 735\cos(0.234t) + 60\cos(0.702t)$.

The System

y in Equation (1) is regarded as a veritable output variable. The strikingly close positive correspondence between its observed y values and the calculated ordinates of y_1 is a direct advice to regard the last mentioned as the input stimulus. The subtracted variable y_2 is then simply an offsetting term, equal to the difference $y_2 = y - y_1$. What this is in substance may be left without comment in the context. Of paramount importance, however, is that one may by mere inspection of Figure 1 become satisfied that the deviations of Eq. (1) from the statistical data are negligible, and that Eq. (1), therefore, approximates the subject growth data truly and concisely.

Still considering Figure 1, it is of interest that already the first approximation, y_1 , is rather intimately associated with the growth curve. In their movement over time, y_1 makes only slight oscillatory deviations on both sides of y . Even these deviations become compensated

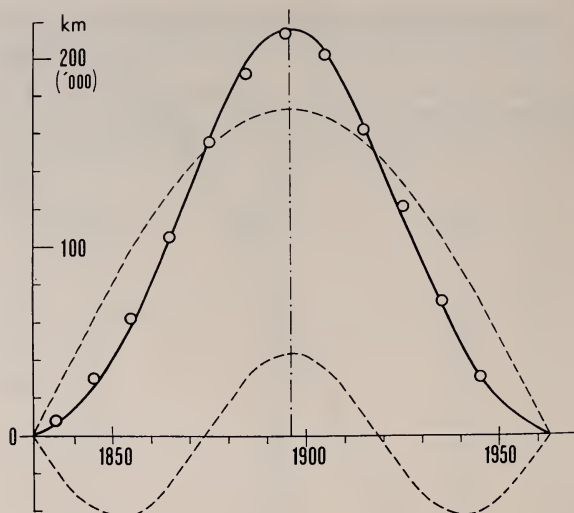


Fig. 2. The Growth Rate of world's railway lines (for legend, see text).
 $\dot{y} = 172\sin(0.234t) - 42\sin(0.702t)$.

for by the second approximation, y_2 . This balanced time-dependent action is an indication that we are dealing with a dynamical system.

In view of this the first and second derivatives of $y(t)$ are considered. Derivating (1) gives

$$\dot{y} = \dot{y}_1 + \dot{y}_2 \quad (2)$$

$$\ddot{y} = \ddot{y}_1 + \ddot{y}_2 \quad (3)$$

These equations are graphed as Figures 2 and 3. Similarly as in Figure 1, the left members are shown by solid lines, whereas the sinusoids are dashed, and the observed points are given by circles. For the last mentioned, use is made of finite differences. The closeness with which the theory fits to observed values is repeated in both cases. Hence one may conclude that the original approximation shown by Eq. (1) is good, the system is linear, and the principle of superposition applies.

While the chart of y was a typical growth curve, that of $\dot{y}$ is a regularly shaped distribution curve. Showing how the decadic increments are distributed over time, this curve lends both form and sub-

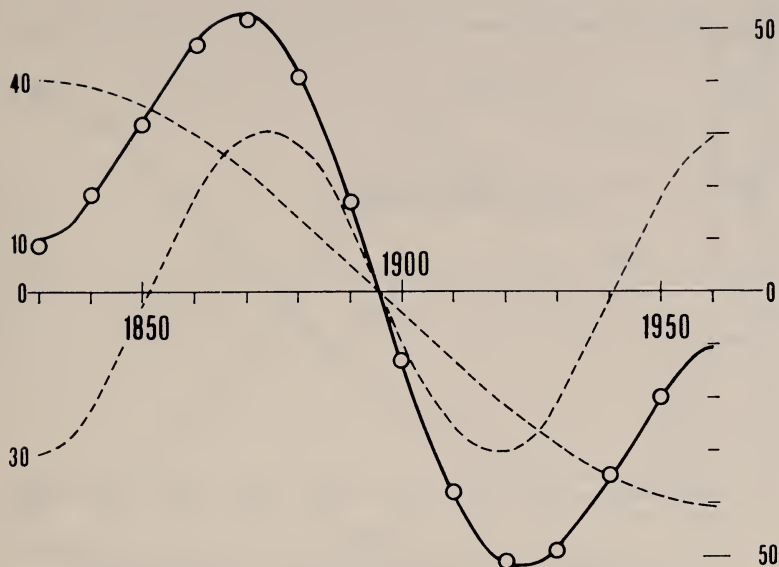


Fig. 3. The Increment of Growth Rate of world's railway lines (for legend, see text).
 $\ddot{y} = 40\cos(0.234t) - 30\cos(0.702t)$.

stance to the hitherto somewhat hazy concept of world's railway mileage and its evolution. Thus made more familiar, the system of world's railway lines might get thematic interest even among geographers.

Included i.e. partial systems

Accepting Eq. (1) as a satisfactory descriptor of the system, one spontaneously asks, what an analogous statistics comprising only a part of the world would look like. This we are going to find out in this section.

The United States is in the world's railway statistics the most important subgroup whose mileage comprised in 1960 twenty-six percent of the world's total. In addition, its centralized statistics, published by the Interstate Commerce Commission, is consistent and highly reliable.

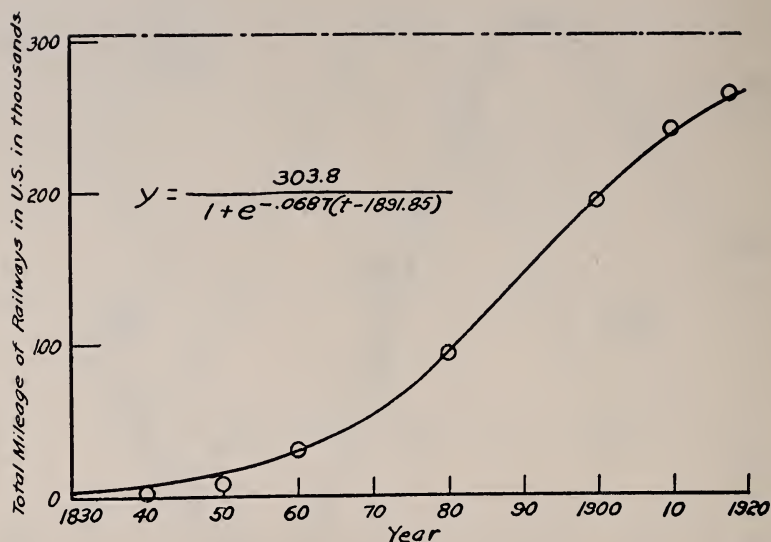


Fig. 4. Growth of American Railways, Verhulst—Pearl fitting.
(Replotted from Lotka, p. 369).

For these reasons and in view of an opportunity to evaluate and compare the fit to the observed values of sinusoidal and another growth function, the said data were chosen. The other type just referred to, dates from 1922 and is known as the Verhulst-Pearl curve of growth. Applied to American railway mileage, it is shown as Figure 4.

Table 2 gives the «Observed» figures and the «Expected» ordinates calculated as well for the Verhulst-Pearl curve as for the sinusoidal approximation, the last mentioned being shown in Figure 5. It is seen that after 1930 the march of the observed and expected values part company because the system in USA experiences a dramatic change in consequence of an extra variate entering the stage and impressing on the system a constrictive action. Also this extra component is shown on that figure.

Comparison of the two last columns of Table 2 makes clear that the sinusoidal approximation describes the data more accurately. Perhaps, therefore, the sinusoidal growth theory is more close to the truth. Anyway, it shows that one may, at least in some case, infer from the whole to its part.

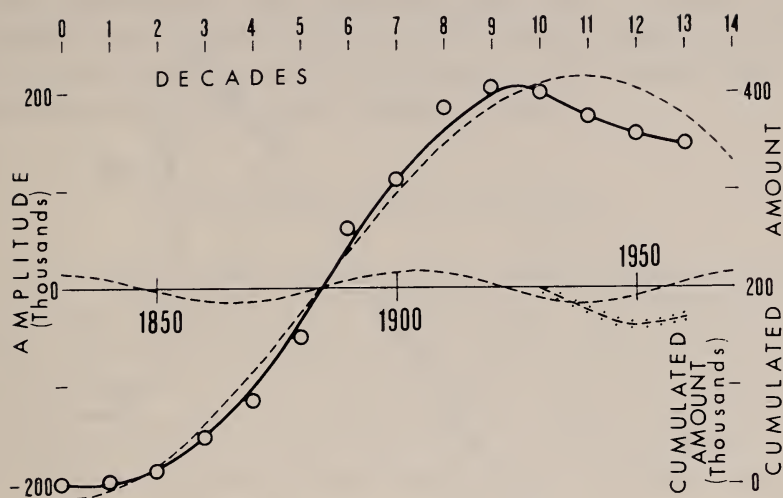


Fig. 5. Growth of American Railways, Sinusoidal approximation. Statistics: ICC Annual Reports, cf Locklin, pp. 83—84. For details, see text.

Table 2. Growth of American railways.

Lines open at the end of the year (thousands).

Year	Observed M*	km	Expected M**	km+	Cumulated Divergence++ M	km
1840	3	4	8	7	3.12	1.28
50	9	15	16	17	6.19	1.52
60	31	49	34	45	6.45	1.88
70	53	85	55	96	6.52	3.14
80	93	150	93	166	6.52	4.68
90	164	262	142	247	9.93	5.59
1900	193	310	193	316	9.93	5.70
10	240	386	236	364	10.00	7.03
20	253	406	264	388	10.46	7.86
30	249	400	283	394	14.54	7.96
40	234	375	293	394		
50	224	359	298	393		
60	218	349	301	380		

* Source: Annual Reports of the Interstate Commerce Commission, cf. Locklin, pp. 83—84.

** $y = 303.8\{1 + \exp[-0.0687(t - 1891.85)]\}$; cf. Lotka, pp. 368—369.

++ $y = -215\cos(0.29t) + 20\cos(0.87t)$; Ajo.

++ $\sum(\text{obs} - \text{exp})^2 / \text{exp}$.

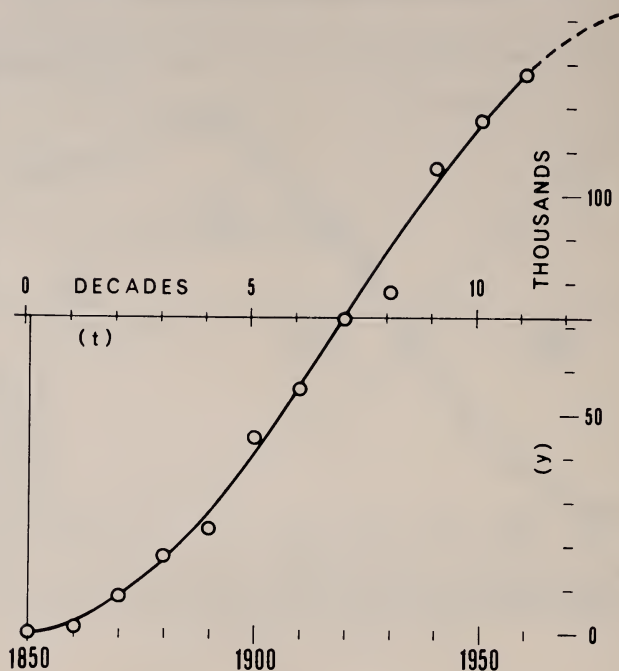


Fig. 6. Growth of Soviet Railways. Statistics: Ry.Dir. 1967 p. 574.
 $y = 72 - 72\cos(0.221t)$.

The Soviets. Let us now take the railway net of Soviets as another example. With its 126 thousand kilometres of railway lines, which is about 9 percent of world's total (1960), it is the next important subgroup in the statistics. More impressive than its line length is the continental size of the system. This is a point of similarity with the USA. Otherwise the two differ greatly.

Conspicuous in the Soviet case is that the growth curve shown as Figure 6 has as yet not reached its ceiling. One would be tempted to say that the net of its railway lines is not yet complete. Another marked difference is that the parameter $a_2 = 0$ with a consequent vanishing of the second sinusoidal term from the right member of y .

It is only natural that individual systems have some distinctive characteristics implied in the describing equations. The more local and restricted the partial system, the more detailed it becomes, and this happens at the cost of discoverable generic features. The clean and mathematically simple features displayed by the whole and, in some

measure, by the two most important parts, get in smaller groups hopelessly lost. Considering the world's railway system as a whole has thus its merits because it behaves as if the innumerable local imprints were dissolved in the totalizing mixture.

Economic aspects of the railway

It is a general opinion that the steam locomotive made the railway. Anyway, the locomotive is the decisive factor that characterizes the railway. The steam locomotive proved this by replacing the horse as motive-power, and so has done the diesel, in its turn, although not so dramatically, and with a great deal less romantic glamour. The epoch-making inventors usually accredited with having constructed the first practical locomotive, made extensive use of old inventions and thus owed much to their predecessors. In fact, they also had to thank the Napoleonic war for the towering cost of horse-fodder which gave them the chance of experimenting (v. Derry-Williams, p. 333).

One reason for the mine owners' distaste for rising fodder prices was that there was no excuse from the rule that starving horses do not drag coal. The workers were more easily managed. For instance the working week was long. All worked 96 hours per week. Also child labour was used for its cheapness.

»Children as young as five years of age worked in damp, poorly ventilated mines . . .; in some underground passages the ceilings were so low that only little boys could get through, dragging the loaded coal buckets.» »The wages were so low as to compel the labor of children in order to survive.» (Friedlaender-Oser, pp. 155—156). This partly explains why the fodder prices were so displeasing and why the mine owners were so eager to get rid of the costly horse traction.

Table 3 gives the number of horses required to pull an equal load in different modes of inland transports before the railway age. The three first rows of the table representing haulage by land make it evident that a further improvement in the then existing conditions was possible only by making use of steam power in lieu of horses. The innovation had thus to combine the advantages of rail with those of steam which substituted coal energy instead of horse-fodder.

Economically, one could expect, the charges levied for the transports by canal ought to be considerably less than those by waggon. Their

Table 3. Number of horses required to pull an equal load by different modes of inland transports.

Sources: Milne, pp. 44—45; Pirath, pp. 139—140.

Load		Horses
Road	Pack	30
—»—	Waggon	6
Rail	—»—	4
Canal	Barge	1

relation could, for instance, be as 1: 6 which would correspond to the numbers of horses used (v. Table 3). This with all the more reason because the capital cost of the horses and waggons required to lift a tonnage equivalent to the capacity of one barge, exceeded the capital cost of the latter by a wide margin. In fact, however, they were only a third or a quarter lower (Milne, *l.c.*). This corresponds with the relation 4: 6 in Table 3 what is to say that the traction by rail was economically competitive with the canal barges.

Against this background it seems that the railway could successfully compete with all then existing means of inland transport if the operating cost of the locomotive did not exceed that of a team of horses pulling a waggon train of equal capacity. It, in fact, did not. Therefore this newcomer had from the very outset to stand out ruthless competition by other modes of transportation, that is: pack-horses, waggons, stage-coaches, barges and canal ships.

We saw that the economic *raison d'être* of railways was to offer cheaper transportation for coal. This requirement became more than satisfied. »Measured by the relative charges levied in the 1830's and 40's rail transport showed itself to be a much less costly form of transport than road transport and also, though by a smaller margin, a less costly method of conveyance than canal transport» (Milne *l.c.*). Therefore the railways not only supplanted the costly horse in the toil on the road link between pit-head and canal or river but it also eliminated the need for trans-shipment from cars to barges.

Notwithstanding this initial superiority and many other advantages, the struggle for existence and foothold continued. Better service and lower cost became a slogan for the developing system of railways. After wages and salaries the most important constituent of operating costs of the railways was always the expenditures for fuel, *i.e.* energy.

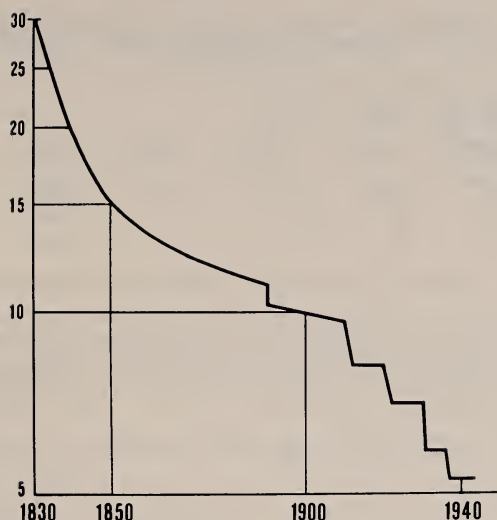


Fig. 7. Evolution of specific steam consumption in locomotives, kilograms per HP-hour (log scale for the ordinates). Replotted from A. Chapelon, S.N.C.F., cf. *Études et conjonctures* 1954, p. 642.

No wonder therefore that economy in consumption of energy became from the very begin the keynote of railway operation.

As an illustration of progress made in the power-economy of steam locomotives during the predominance of steam traction, Figure 7 shows the lowering of steam consumption in the locomotive engine. From its original value, 30 kg per HP-hour in 1830, it was brought down to only 5.2 kg, about 1940.

In spite of this and other improvements, the steam locomotive is actually almost obsolete. Diesel engines have been placed in service since about 1930 because they can be operated at about half the cost of the steam locomotive (Bigham and Roberts, p. 84). Subsequently the diesel has continued in replacing the steam locomotive, although significantly improved types of the latter have also appeared on the rails (*ibid.*).

Dieselization, however, does not represent the highest possible level in the progress towards better economy in the consumption of energy. Gas turbines have been tried, and electric transmission from atomic power plants is already taken into consideration. This means that the specific energy consumption on the railways has a diminishing trend.

Table 4. *Trend of energy consumption on the railways (all forms of energy). Total for Belgium, West-Germany, France, Holland, Italy, Luxemburg, Austria and Switzerland.*

Source: Seidenfus, pp. 11 and 12.

1950	1955	1960	1965	1970
100	98	86	80	68

Seidenfus gives a series of calculated energy consumption estimates for the railways of seven West-European countries. Instead of absolute numbers we, however, represent the evolution by index figures. Putting 100 for the consumption in year 1950, Table 4 is obtained.

Evidently the dieselization together with other major improvements has not only saved the American railways from further abandonment of obsolete lines, but they have made it possible for the railway to recover from the effects of disastrous competition with rivalling means of transportation. Figure 5 shows the net effect of the said impressed disturbance as an additional component plotted as $+++$. Starting from zero in 1930, its negative gradient soon levels off to rise again towards a new balance. The other components are simply dashed as was done in Figures 1, 2, and 3.

Stress is laid on the fact that the additional component portrays the net effect of a severe negative action which was alleviated but not wholly offset by the extraordinary powerful positive measures then applied. In this connection it can be said that the disturbance met with in the American system of railways is to a great extent due to the control mechanism which allowed the economizing measures to come out of step with the encountered economic difficulties.

How the system works

The inventions, ideas and other »prime movers» do not come in our consciousness by slow and secretive oozing in. On the contrary, they most usually do it in a flash, as an impulse or a train of impulses.

For instance, the mine owners were potential railway builders because they needed cheap transports for coal. For them the result of the Rain Hill competition was an effective impulse of excitation

Table 5. *Railway statistics from the economic era before the World War 1.*
 Source: Table 1 and Lesourd—Gérard, pp. 258—260.

	Thousands of kilometres			1914
	1850	1914	Av. per Decade	Density km/100 km ²
World	34	1000	151	.7
USA	15	424	64	1.9
Russia	.2	74	12	.3

to which impressed psychological input they responded by starting to project new railways and placing orders for locomotives. The locomotive had done this. In the consecutive progress new impulses turned up in great numbers. They represented new ideas, new needs, and new possibilities.

The more frequent the impulses the more potent the input stimulus and the greater the effected output. The cause must, of course, be measured by its effect. A practical unit was found to be 1000 kilometres of line length. Accordingly, the input impulse frequency must in each decade be proportional to the pertinent net length of lines built as the output. This is analogous to the modulation of impulse frequency by which mode the nerve system of Man communicates stimuli and their strengths (*v.* Hassenstein, p. 51; also Bliss, p. 14).

The system and geography

Thus far we have considered world's railway lines in the time domain that is, as a function of time. The length of lines in a given point of time, and the increment per decade, are found to obey simple mathematical laws. Hence the regularity of the curves representing the said functions. This regularity, however, is totally lost as soon as we quit the time domain and enter the geographical realm.

As a matter of fact it must be pointed out that the enorm growth of the railway lines to a length of 1350 thousand kilometres in 130 years has not taken place uniformly all over the world. To illustrate this, Table 5 is presented. In addition it is mentioned that in most countries of Europe the line density in year 1914 was about 10 km/100 km². For Belgium the density was greatest, *viz.* 30.

In spite of this seeming irregularity in the global distribution of

railway potential, the subject does not fall outside the bounds of geographers' interest. It must not. Knowing what the system looks like in the time domain will be of great help to geographical analysts even when only a part of the system is considered. Possibility to set the considered region in proper historic, economic, a.s.o. relation to the whole is already of paramount importance, not to speak of other advantages a quantitative knowledge offers.

LITERATURE

- Bayliss, L. E. (1966). *Living Control Systems*. 189 p. London: Univ. Press.
- Bigham, T. C. and Roberts, M. J. (1952). *Transportation, Principles and Problems*. 710 p. New York: McGraw-Hill.
- Derry, T. K. and Williams, T. L. (1960). *A Short History of Technology*. 782 p. Oxford: Clarendon.
- Fridlaender, H. E. and Oser, J. (1953). *Economic History of Modern Europe*. 611 p. New York: Prentice-Hall.
- Hassenstein, Bernhard (1966). Was ist 'Information'? *Naturwissenschaft und Medizin* 13, 38—52.
- Lesourd, Jean-Alain, et Gérard, Claude (1963). *Histoire Economique XIX^e et XX^e siècles*. Tome 1: 292 p. Paris: Colin.
- Locklin, Philip D. (1960). *Economics of Transportation*. 873 p. Fifth Ed. Ill., USA.
- Lotka, Alfred J. (1924; 1956). *Elements of Mathematical Biology*. 465 p. Dover, New York.
- Malvestiti, Piero (1961). *Die Energiequellen und die Industriellen Revolutionen*. 56 p. Hohe Behörde, Luxemburg.
- Migliorini, Elio (1956). *La Terra e le Strade*. Seconda Edizione. 245 p. Napoli.
- Milne, A. M. (1955; 1960). *The Economics of Inland Transport*. 292 p. London: Pitman.
- Pearl, Raymond (1922). *The Population Problem*. *Geographical Review* 12, 636—645. New York.
- Seidenfus, Hellmuth Stefan (1960). *Energie und Verkehr*. 229 + 62 p. Tübingen: Mohr.

Anonymous:

- Ency.Brit. = Encyclopedia Britannica 1953, Vol 18. London.
- »Évolution du prix des principales sources d'énergie dans le monde depuis 1938». pp. 640—676. *Études et Conjonctures* 1954, Nr. 7. Paris.
- IT = Iso Tietosanakirja 1936. Vol. 10. Helsinki.
- Ry.Dir. = Railway Directory and Year Book 1967—68. 1967, London.
- UT = Uusi Tietosanakirja 1964, Vol. 16; Helsinki.

**BEVÖLKERUNGSVERÄNDERUNGEN IM
BEREICH VON BUDAPEST IN DEN
JAHREN 1869-1966**

von

KALEVI RIKKINEN und FERENC PROBÁLD

HELSINKI 1969

Am 21. März 1969 vorgelegt von
Reino Ajo und Veikko Okko

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ABSTRACT

This study focuses upon the relationship between population change and distance from the center of Budapest during the 1869—1966 interim. The study area consists of 147 statistical units within a radius of 35 kilometers from Budapest. The population change-distance relationship has been analyzed by using separate graphic representations for the areas west and east of the Danube River. Median population change curves depict the general population transition-distance relationship for the following periods: 1869—90, 1890—1910, 1910—20, 1920—41, 1941—49, 1949—60 and 1960—66. The usefulness of the median curve as a tool in representing population change by individual statistical area is also discussed. The development of the transportation system, in addition to special factors which characterize the Budapest region, have been utilized to explain the changes.

EINLEITUNG

Der Einfluss zentraler Orte auf die Verteilung und zahlenmässige Entwicklung der Bevölkerung, sowie die mit der Zeit ständig zunehmende und sich im Raume ausbreitende Wirkung derselben stellt ein hochinteressantes geographisches Untersuchungsobjekt dar, vor allem weil es den Mechanismus des zum Weltproblem angewachsenen Urbanisationsprozesses beleuchtet. Zweck dieser Untersuchung ist es, die zwischen den Bevölkerungsveränderungen und der Entfernung vom Stadtzentrum bestehenden Beziehungen im Bereich von Budapest in den Jahren 1869—1966 zu erforschen.

Die Aufdeckung der eigenartigen Merkmale der Bevölkerungsentwicklung im Einflussbereich einer Stadt ist an sich schon lohnend, kann aber auch zur Feststellung allgemeiner Gesetzmässigkeiten beitragen, da diesen stets eine möglichst grosse Anzahl von Einzeldarstellungen zu Grunde liegt. Obgleich in diesem Aufsatz das Problem am Beispiel der Stadt Budapest erörtert werden soll, sei vorerst ein Blick auf die früheren Untersuchungen ähnlicher Fragestellung geworfen.

Das Problem ist von zahlreichen Autoren mit verschiedenen Methoden und in verschiedenen Massstäben behandelt worden. Das untersuchte Gebiet ist manchmal nur der Stadtkern (z.B. Kant 1962, S. 348—355), aber zuweilen das ganze, auch viele ländliche Siedlungen umfassende Einfluss- oder Verkehrsgebiet der Stadt gewesen (z.B. Ajo 1944, Hult 1962). In einigen Aufsätzen hat man Grossstadtgebiete oder andere Stadtbereiche behandelt, die ihrer Grössenordnung nach zwischen dem Stadtkern und dem ganzen Einflussgebiet liegen (z.B. Brush 1968).

Ungeachtet des gewählten Massstabes ist es für die meisten Untersuchungen seit den Zeiten von Thünen kennzeichnend, dass in den Mittelpunkt des Interesses stets die *Dichte* der Bevölkerung sowie ihre zeitlichen Wandlungen gestellt wurden. Man hat immer wieder versucht, die Dichte der Stadtbevölkerung sowohl räumlich wie auch zeitlich verallgemeinert und vergleichend zu behandeln. Clark (1951) veröffentlichte einen viel zitierten Aufsatz über die Variationen der städtischen Bevölkerungsdichte, der auf der Untersuchung vieler Gross- und Riesenstädte fusste. Zur Erfassung der Veränderungen hat er — wie die meisten Autoren, die sich mit diesem Problem befassten — die Bevölkerungsdichte für konzentrische, um den Mittelpunkt der Städte gelegene Kreis- bzw. Ringflächen berechnet. Clark kam zu demselben Ergebnis, wie Bleicher (1892) 60 Jahre früher, nämlich dass die Bevölkerungsdichte im allgemeinen mit der Entfernung vom Stadtmittelpunkte abnimmt, und sich zudem durch die folgende Exponentialgleichung ausdrücken lässt:

$$P_d = P_o e^{-bd},$$

wo P_d die Dichte der Wohnbevölkerung in der Entfernung d , P_o die Dichte im Zentrum, b den Dichtegradient und d den Radialabstand vom Stadtzentrum bezeichnet. Nach Clark stellt diese Formel die Abnahme der Bevölkerungsdichte mit der Entfernung von der Stadtmitte — mit mehr oder weniger Abweichung — für alle Städte von Budapest bis Los Angeles dar.

Die späteren Untersuchungen haben die Gültigkeit dieser Exponentialfunktion in grossen Zügen für viele Hunderte von Städten nachgewiesen (Berry, Simmons und Tennant 1963, S. 390—391). Jedoch hat man zahlreiche Variationen dieser allgemeinen Regelmässigkeit gefunden. Man hat insbesondere die Dichte im Zentrum (P_o) und den Dichte-

gradient (b) in verschiedenen Städten untersucht, und beträchtliche Unterschiede gefunden (Haggett 1966, S. 155—158).

Clark (*op. cit.*) hat auch den zeitlichen Ablauf der Dichteveränderungen untersucht; nach ihrer Feststellung wird der Dichtegradient mit der Zeit immer kleiner. Die Bevölkerungsdichte im Zentrum befindet sich zuerst im Ansteigen, beginnt aber nach einer gewissen Zeit wieder abzunehmen (Entvölkerung des Stadtzentrums). Diese beiden von Clark festgestellten Regelmässigkeiten erwiesen sich im Falle vieler europäischer und amerikanischer Grossstädte als stichhaltig (Kant 1962, S. 337—340). Berry *et al.* (1963) konstatierten hingegen, dass der Dichtegradient indischer Städte nicht kleiner geworden ist, weil dort die Bevölkerungsdichte selbst im Stadtzentrum noch in Zunehmen begriffen ist. Das lässt sich nach Berry *et al.* dadurch erklären, dass in Indien die Verkehrsverhältnisse nicht so gut entwickelt sind, wie z.B. in den europäischen Ländern. Aber nach der jüngsten Untersuchung (Brush 1968, S. 374) sind die Verhältnisse auch in Indien so komplex, dass man sie mit einer einfachen Formel nicht erfassen kann.

Wenn es sich um ein grosses, auch ländliche Siedlungen und offene Räume umfassendes Gebiet handelt, wie es z.B. bei dem Einflussbereich von Budapest der Fall ist, sind die *relativen Veränderungen* der Einwohnerzahl vielleicht besser und einfacher zur Erschliessung der Entwicklungstendenzen geeignet, als die sehr unterschiedlichen Werte der Bevölkerungsdichte. Obgleich diese Methode gewisse Vorteile hat, und auf die Veränderung der Bevölkerungsdichte ebenfalls schliessen lässt, wurde sie bis jetzt bei nicht sehr vielen Städten angewendet.

Ajo (1963) hat in seiner Untersuchung über Helsinki, Stockholm und Oslo festgestellt, dass die Trendlinie der Veränderungen der Einwohnerzahl mit der Entfernung von der Stadtmitte während eines Jahres (1960—61) sich ähnlich der Sinuskurve verhielt, ebenso wie die Trendlinie von London, die auch für dasselbe Jahr errechnet wurde (Ajo 1964). Diese Ergebnisse stimmen gut mit denjenigen einer früheren Untersuchung über Tampere (Ajo 1961) überein, nach der die Verteilung der Stadtbevölkerung mit der Entfernung von der Stadtmitte früher (vor dem Jahre 1900) durch eine Kosinuskurve, später aber durch eine Sinuskurve illustriert werden konnte.

Von den meisten früheren Verfahren abweichend, wurden in der Untersuchung über Bevölkerungsveränderungen im Duluth-Bereich

nicht nur Zonen desselben Abstandes, sondern alle Teilgebiete in der Umgebung der Stadt selbständig bei der Analyse berücksichtigt (Rikkinen 1968). Man konnte feststellen, dass die durchschnittlichen Veränderungen mit der zunehmenden Entfernung von der Stadtmitte (für die Perioden 1930—40, 1940—50 und 1950—60) sich auch hier meistens kurvenförmlich verhielten. Bei der getrennten Untersuchung von Dörfern und Streusiedlungen wiesen die Veränderungen während der letzten Periode (1950—60) grosse Ähnlichkeit auf, während früher die Entwicklung der Dörfer und Streusiedlungen beträchtliche Abweichungen zeigte. Es war also nach dieser Studie nicht möglich, die Bevölkerungsveränderungen für jeden Zeitabschnitt mit einer einfachen Formel wiederzugeben. Die Analyse wurde mit Hilfe der graphisch-statistischen Darstellungsmethode gemacht; ausschliesslich dieselbe Methode soll auch in der vorliegenden Studie über Budapest gebraucht werden.

BUDAPEST ALS UNTERSUCHUNGSOBJEKT

Bei der Untersuchung der Veränderungen der Bevölkerungszahl in einem Stadtbereich muss man sich stets vor Auge halten, dass die Arbeit den Zweck verfolgen soll, möglichst vielseitig nicht nur die Tatsachen, sondern auch deren Gründe, sowie die wirkenden Faktoren, den Mechanismus und die weiteren Tendenzen der Veränderungen zu klären. Erst daraus wird hervorgehen, wieweit man aus den erfassten Gesetzmässigkeiten allgemein gültige Folgerungen ziehen kann. Zur richtigen Auslegung der Ergebnisse ist es wohl unerlässlich, vor allem das Untersuchungsobjekt, die Stadt Budapest und deren eigentümliche Entwicklung, kurz vorzustellen.

Die Einwohnerzahl der ungarischen Hauptstadt Budapest hat Anfang 1969 die 2 Millionen-Grenze überschritten, und damit Miskolc, die zweitgrösste Stadt des Landes, etwa 12-mal übertroffen. In Budapest leben heute rund 20 v.H. der gesamten Bevölkerung von Ungarn. Es gibt in Europa, wenn man die Zwergstaaten ausser acht lässt, nur zwei Hauptstädte: Wien (23 %) und Kopenhagen (29 %), die einen noch grösseren Anteil an der Bevölkerung ihres Landes aufweisen (Bencze 1963, S. 102—103). Dabei muss bemerkt werden, dass die mächtige Agglomeration von Budapest schon stark über die Verwaltungsgrenzen hinausgreift, und über 2,3 Millionen Einwohner zählt (Bertalan

1968, S. 32). Als Verwaltungs-, Verkehrs-, Handels- und Kulturzentrum steht Budapest in Ungarn ohne seinesgleichen da; seine wichtigste, die Entwicklung am meisten beeinflussende Funktion stellt aber die Industrie dar, in der etwa 47 % der Beschäftigten tätig sind (Központi Statisztikai Hivatal 1968). In Jahre 1930 erreichte ihr Anteil an der gesamten Industrie des Landes — aufgrund der Zahl der Beschäftigten — fast 60 %, und beträgt selbst heute noch etwa 40 % (Kóródi und Márton 1968, S. 89, 103; Központi Statisztikai Hivatal 1968).

In der früheren Periode — von der Römerzeit bis zur industriellen Revolution — haben vor allem physisch-geographische und militär-geographische Faktoren zur Entwicklung der Stadt beigetragen (ausgiebige Quellen, reichlich zur Verfügung stehendes Baumaterial, naturbegünstigte Übergangsstelle an der Donau). Seit Beginn der raschen Entwicklung der kapitalistischen Grossindustrie in Ungarn — d.h. von der zweiten Hälfte des 19. Jahrhunderts an — traten wirtschaftliche Wirkungsfaktoren in den Vordergrund. Die Westseite der Donau (Buda) und die Ostseite (Pest) wurden 1872 zu einer Stadt vereinigt. Budapest wurde das Zentrum des völlig radial aufgebauten Eisenbahn- und Strassennetzes von Ungarn, und wichtiger Hafen der Donauschifffahrt. Seine Lage an der Grenze zweier verschiedener Grosslandschaften (Mittelgebirge und Grosse Tiefebene) und gleichzeitig in der Mitte des vom historischen Ungarn umfassten Karpatenbeckens bedeutete ebenfalls einen grossen Vorteil. Die ausserordentlich günstige Verkehrslage zog viele Zweige der verarbeitenden Industrie an. Die dadurch entstandenen Vorteile der Kooperationsmöglichkeiten — und nebenbei auch die Energiequellen der naheliegenden Braunkohlenreviere — haben das auch weiterhin rasche Entwicklungstempo und schliesslich das industrielle Übergewicht von Budapest zu Folge; damit ging selbstverständlich auch die schnelle Konzentration der Bevölkerung vonstatten.

In den letzten 20 Jahren verfolgte die Wirtschaftspolitik des sozialistischen Staates das Ziel, durch die Bevorzugung der Standorte in der Provinz das Missverhältnis in der gebietsmässigen Verteilung der Produktion zu vermindern; das industrielle Entwicklungstempo der Hauptstadt ist seitdem tatsächlich leicht unter demjenigen des Landes geblieben. Trotzdem hat sich zwischen 1948 und 1966 die Anzahl der Beschäftigten in den Budapester Industrie um das 2,6 -fache, der Produktionswert um das 5-fache erhöht (Kóródi und Márton 1968, S. 103). Das war unvermeidlich, da eine schnelle Produktionssteigerung vor

allem durch grosszügigen Wiederaufbau und Erweiterungen bestehender Betriebe erzielt werden konnte. Da die Stadt selbst der rapiden Zuwanderung der Arbeitskräfte nicht mehr gewachsen war, erweiterte sie ihren Einflussbereich weit über die seit dem Jahre 1950 525 km² umfassenden Verwaltungsgrenzen hinaus, wodurch eine starke Zunahme der Pendelwanderung zu verzeichnen war.

Im Jahre 1960 hat die Regierung einen Beschluss gefasst, nach dem in Budapest lediglich die Gründung neuer Betriebe verboten ist, und einige bestehende Betriebe zur neuen Standortwahl und Umsiedlung verpflichtet wurden. Die Beschränkungen für die Entwicklung der Industrie gelten auch für 64 andere Siedlungen in der unmittelbaren Umgebung von Budapest. Der Beschluss sieht eine stärkere Entwicklung von 5 grossen Provinzstädten Ungarns vor, die Budapest das Gegengewicht halten sollen (Kóródi und Márton 1968, S. 31).

Während bis zum Jahre 1963 der Anteil Budapests an der gesamten Zunahme der Industriebeschäftigten stets über 30 % geblieben war, ist er seitdem immer geringer geworden, und in den letzten drei Jahren lässt sich sogar eine absolute Abnahme verzeichnen (Kóródi und Márton, S. 95). Der positive Migrationssaldo der Hauptstadt ist von 42 000 (1960) auf 18 000 (1967) zurückgegangen (Központi Statisztikai Hivatal 1968). Die Anzahl der Pendler, die laut der Volkszählung im Jahre 1960 etwa 140 000 betrug (Palotás 1965, S. 222—236), ist auch weiterhin noch im Ansteigen begriffen, und soll in den letzten Jahren 160—170 000 erreicht haben (Bertalan 1968, S. 32—33; Kóródi und Márton 1968, S. 96). Mit einer anderen Methode konnte eine noch höhere Anzahl (über 200 000) von Pendlern ermittelt werden, und so dürften etwa ein Fünftel aller Berufstätigen im Budapest zu den Einpendlern gezählt werden (Palotás 1968, S. 272, 274).

Aus dem bisher Gesagten geht hervor, dass es sich im Falle von Budapest um einen ausserordentlich stark entwickelten zentralen Ort höchsten Ranges handelt, dessen Einflussbereich auch hinsichtlich der Bevölkerungsdichte und der Veränderung der Einwohnerzahl ein grosses Gebiet umfasst. Zwar gibt es einige Studien, die den Zweck verfolgen, die wichtigsten Eigenschaften des Arbeitskraftanziehungskreises der Hauptstadt auch hinsichtlich der Bevölkerungsentwicklung aufzuzeigen (Tajti 1962, 1967), doch wurde diese Entwicklung in einer längeren Periode und in einem grossen Gebiet nicht mit statistisch-graphischen Methoden analysiert, noch weniger in einer Form, die den Vergleich mit anderen Untersuchungen im Falle anderer zentra-

len Orte ermöglicht hätte. In Richtung dieser beiden erwähnten Zwecke soll durch die vorliegende Arbeit ein Beitrag geleistet werden. Im folgenden werden vorerst die Abgrenzung des untersuchten Gebietes sowie die Quellen und Methoden der Untersuchung geschildert.

ÜBER DIE METHODEN DER UNTERSUCHUNG

Das untersuchte Gebiet ist von einem Kreis mit 35 km Radius umgrenzt, dessen Mittelpunkt im Stadtzentrum Budapests liegt (Kettenbrücke, A. Clark-Platz). Dieses Gebiet umfasst ausser den 22 Bezirken der Hauptstadt noch 125 andere Siedlungen. Die Grenze des Arbeitskraft-Anziehungskreises, in dem die demographischen Prozesse jedenfalls stark den Einfluss der Hauptstadt widerspiegeln, verläuft im NW in einer Entfernung von etwa 30 km, anderswo aber mehr als 35 km vom Stadtkern entfernt; im Osten und Südosten soll sie nach Tajti (1962, S. 264) an mehreren Stellen entlang den Eisenbahnlinien sogar die Entfernung von 60 km überschreiten. Tajti hatte zur Abgrenzung des Anziehungskreises die Linie benutzt, an der der Pendlerverkehr in den beiden entgegengesetzten Richtungen als gleich gross berechnet war. Dieses Gebiet enthält etwa 185 Siedlungen (Tajti 1962, S. 264). Die Wohnorte des weit überwiegenden Teils der Pendler müssen aber innerhalb der 35 km-Linie liegen.

Zur Klärung der Tendenzen der historischen Entwicklung steht uns das statistische Material der seit 1869 in jedem Jahrzehnt stattgefundenen Volkszählungen zur Verfügung. Die Einwohnerzahl wurde auf die gegenwärtigen Verwaltungs-bzw. Gemeindegrenzen auch rückläufig umgerechnet und veröffentlicht (Központi Statisztikai Hivatal 1961 a, b, c, d). Diese zuverlässigen Angaben, die ein ganzes Jahrhundert, und zwar die Epoche des rapiden Aufstiegs der Hauptstadt umfassen, bilden eine ausgezeichnete Grundlage für wissenschaftliche Arbeiten. Die Angaben über die Einwohnerzahl Anfang 1966 liessen sich aus den Statistischen Jahrbüchern der einzelnen Komitate bzw. Budapest entnehmen (Központi Statisztikai Hivatal 1967).

Aus den oben erwähnten Angaben ist für diese Studie die relative, in Prozenten ausgedrückte Veränderung für die Perioden 1869—1890, 1890—1910, 1910—1920, 1920—1941, 1941—1949, 1949—1960 und 1960—1966 errechnet, und in einem Koordinatensystem dargestellt,

indem an der Abszisse die Entfernung der Gemeinden (der Bezirke) vom Stadtzentrum Budapest, an der Ordinate die relative Ab- bzw. Zunahme der Einwohnerzahl vermessen wurde (Beilagen I und II).

Die Entfernung der einzelnen Gemeinden wurde vom Stadtzentrum Budapest bis zum visuellen Mittelpunkt des Dorfes in Luftlinie gemessen. Es ist bekannt, dass die gleiche Intensität des Einflusses der Grossstadt in bevölkerungsgeographischer Hinsicht nicht von der gleichen geometrischen Entfernung, sondern von den verkehrsbedingten Isochronlinien bestimmt ist. Die Anwendung der Verkehrskosten-Entfernungen, wie es von Lackó (1967, S. 329) vorgeschlagen wurde, der Isochronlinien, denen bei dem Pendelverkehr von Budapest wohl die grösste Bedeutung zukommt, oder von Zugänglichkeits-Entfernungen (Seyfried 1963, S. 275—284) wäre in diesem Fall jedoch schwierig und noch dazu gar nicht zweckmässig gewesen, da die Rekonstruktion der mehrfachen Veränderungen der Verkehrsverhältnisse während des behandelten Jahrhunderts nicht möglich ist. Der Unterschied zwischen der geraden und der verkehrsbedingten Entfernung ist gegenwärtig — wegen des gut entwickelten Verkehrsnetzes — in der Umgebung der Grossstadt nicht mehr beträchtlich.

Wenn man sich bei der Bestimmung des Abstandes und bei der graphischen Darstellung die Bevölkerung der einzelnen Gemeinden in einen Punkt zusammengezogen vorstellt, ist dieses Verfahren vollkommen gerechtfertigt, denn im Kern dieser Gemeinden liegt immer ein dicht bebautes Dorf oder eine Kleinstadt, während die z.B. in Finnland recht verbreiteten Streusiedlungen auf unserem Gebiet unbedeutend sind; ihre Einwohnerzahl beträgt hier nicht mehr als 6—7 % der ländlichen Bevölkerung. Im Fall der Bezirke der Stadt Budapest hingegen liegt dem Abstand von der Stadtmitte eine ziemlich grobe Schätzung zu Grunde, da diese auch in radialer Richtung eine beträchtliche Ausdehnung aufweisen.

Wir haben im Einflussbereich von Budapest die östlich und westlich der Donau liegenden Gebiete voneinander getrennt, weil ihr Charakter durch die folgenden bedeutenden Unterschiede gekennzeichnet ist:

a. An der Westseite der Donau (in Transdanubien) finden wir Hügelland und niedriges Mittelgebirge, während die östliche Seite grösstenteils Ebene ist (Grosse Ungarische Tiefebene).

b. Das Relief hatte auf der Westseite die regelmässige Entfaltung des Vorstadtgürtels — mit Ausnahme des eigentlichen Donautales —

verhindert, auf der Ostseite hingegen konnte sich der Einflussbereich der Stadt ungestört ausbreiten.

c. Die Verkehrsverhältnisse sind östlich der Donau — auf das Eisenbahnnetz gestützt — stets besser gewesen, während westlich der Donau das Eisenbahnnetz weniger entwickelt, und erst in den letzten Jahrzehnten durch den Autobusverkehr eine wesentliche Besserung eingetreten ist.

d. Der Einflussbereich von Budapest ist im Westen nicht nur durch die Verkehrsverhältnisse, sondern auch durch die Anziehung benachbarter Industriegebiete (Dunaujváros, Székesfehérvár, Tatabánya, Esztergom-Dorog), im Osten hingegen, und ganz besonders im SO-Sektor, wo die Agrargebiete weit überwiegen, erst durch die beträchtliche Fahrzeit bei grosser Entfernung beschränkt.

In den Diagrammen (Beilagen I und II) sind die Bahngemeinden durch ein anderes Zeichen unterschieden, weil es bekannt ist (Tajti 1962, S. 267), dass die Entwicklung der Gemeinden mit Eisenbahn seit 1869 viel schneller vor sich ging, obgleich in den letzten Jahrzehnten der Unterschied geringer geworden ist.

Bei der Bestimmung der durchschnittlichen Veränderungen (*Mediankurven*), die in den Diagrammen der Beilagen dargestellt sind, sind die Medianwerte der Veränderung in der Einwohnerzahl der einzelnen Gemeinden in jeder, 5 km Distanz umfassenden Zone benutzt.¹ In den Diagrammen sind auch durchschnittliche Veränderungen der Bevölkerung ganz Ungarns dargestellt.

ANALYSE DER DIAGRAMME

PERIODE 1869—1890 (Beilage I)

Zwar erhöhte sich die Einwohnerzahl von zwei alten Zentrumbezirken nur mässig, aber die der Stadtmitte unmittelbar naheliegenden Bezirke (Entfernungszone 2—13 km) wiesen die höchsten Zuwachsraten auf. Die Grenze zwischen der Stadt und den ländlichen Gemeinden der Umgebung war zu dieser Zeit noch sehr deutlich (vgl. die Karte bei Illyefalvi 1933, S. 103), und dieser krasse Unterschied ist auch in der

¹ Da bei diesem Verfahren den Gemeinden verschiedener Grösse dasselbe Gewicht zukommt, wurde auch die prozentuelle Veränderung in der Einwohnerzahl des Gesamtgebietes der einzelnen Zonen berechnet. Das Ergebnis wies sehr grosse Ähnlichkeit mit demjenigen des vorher genannten Verfahrens auf.

Entwicklung der Bevölkerung sichtbar. Der verschiedene Charakter der rechten und linken Seite der Donau kommt schon klar zum Vorschein. Westlich der Donau befinden sich nur zwei dem Stadtkern benachbarte Bezirke in raschem Aufschwung, darum ist der Veränderungsgradient hier nicht so steil, wie auf der Ostseite. Während in der Zone zwischen 15 und 20 km die Zunahme der Bevölkerung etwa dem Landesdurchschnitt (20 %) entspricht, erhöhen die Gebiete grösserer Entfernung ihre Einwohnerzahl in noch geringerem Mass. Die fortschreitende Verdichtung der Bevölkerung in der Stadt erhält ihren Nachschub zu dieser Zeit offenbar in erster Reihe aus diesen naheliegenden Gegenden.

PERIODE 1890—1910 (Beilage I)

Zwischen 1890 und 1910 hat die Hauptstadt Budapest ihre Einwohnerzahl beinahe verdoppelt; es war eine Epoche reger Bautätigkeit und Entwicklung (Illyefalvi 1933, S. 106—107). Zu dieser Zeit finden wir bei fortdauernd schneller Zunahme der Einwohnerzahl der inneren Bezirke in der Zone 10—15 km die höchsten Zuwachsraten. Das ist ein klares Zeichen der beginnenden Ausbildung des Vorortgürtels von Budapest, in dem Fabriken, Bahnhöfe, Lagerhäuser usw. von grossem Raumbedarf mit Wohnvierteln verflochten sind (zweiter Wohngürtel, vgl. Mendöl 1963, S. 416—417). Die Bevölkerung der Zone 30—35 km weist selbst östlich der Donau noch weiterhin eine unter dem Landesdurchschnitt liegende Zunahme auf, ist also von dem Agglomerationsprozess zuerst negativ beeinflusst. Die Überlegenheit der Gemeinden mit Eisenbahnverbindung kommt während dieser Zeit am deutlichsten zum Ausdruck. Die meisten Dörfer, die keine Eisenbahn haben, erhöhen ihre Einwohnerzahl weniger als das ganze Land (26,6 %). Das ist die Ursache der grossen Streuung der Zuwachsraten, die in der Distanzzone 15—35 km zu beobachten ist.

Im Westsektor des Einflussbereiches, wo die Entwicklung des industriellen Vorstadtgürtels nur sehr beschränkt vor sich ging, erhöhen weiterhin die inneren Stadtbezirke ihre Einwohnerzahl am meisten. Der Scheitelpunkt der Mediankurve rückte aber auch hier etwas weiter vom Zentrum (3—5 km) ab. Das Diagramm bietet ein Bild, das demjenigen des Ostsektors in der vorigen Periode ähnelt; die Naturgegebenheiten erwecken hier den Eindruck, als ob die allgemeine Entwicklung derjenigen an der Ostseite stets nachhinke.

PERIODE 1910—1920 (Beilage I)

Diese Periode steht stark unter dem Einfluss des ersten Weltkrieges. In dem gegenwärtigen Staatsgebiet vom Ungarn wuchs die Bevölkerung nur um 4,9 %, und selbst im Gebiet von Budapest war eine Zunahme von nur 11,0 % zu verzeichnen.

Die Form der Mediankurven zeigt eine Entwicklung, die in grossen Zügen derjenigen der vorigen Periode ähnlich ist. Es ist aber auffallend, dass die Einwohnerzahl einiger Bezirke in der Nähe des Zentrums, die früher eine schnelle Zunahme aufgewiesen hat, sich während dieser Zeit sogar vermindert. Das hat mit der normalen Entwicklung der Stadt nichts zu tun, und ist wohl mit einer allgemeinen Lähmung des Wirtschaftslebens der Hauptstadt zu erklären, die selbstverständlich auch auf die Bevölkerung nicht ohne Auswirkung geblieben ist. Die später weiter andauernde Zunahme liefert den Beweis, dass man im Fall dieser Bezirke noch nicht von der Erreichung einer »kritischen Dichte« (vgl. Newling 1966, S. 225) sprechen kann.

PERIODE 1920—1941 (Beilage II)

Die ganze Bevölkerung Ungarns wuchs während dieser Periode um 16,6 %, aber auf dem heutigen Gebiet der Hauptstadt erreichte die Zunahme den viel höheren Wert von 39,5 %. Die Diagramme zeigen grosse Ähnlichkeit mit der letzten Periode vor dem Kriege, nach der kurzen Unterbrechung setzt also die normale Entwicklung wieder ein. Ein wesentlicher Unterschied liegt darin, dass die Bevölkerungszunahme des Stadtkerns sich weiter vermindert, wenn auch von einer Entvölkerung noch keine Rede sein kann, während die Zone von 15—20 km Entfernung, deren Dörfer selbst heute noch nicht zur Hauptstadt gehören, einen starken Vorstoss aufweist. Das lässt sich durch die beginnende Pendelwanderung in Richtung der zweiten, äusseren Industriezone der Vorstädte erklären. Der Agglomerationsvorgang hat im Ostsektor die Zone 30—35 km, im Westsektor die Gebiete von mehr als 20 km Entfernung noch nicht erreicht (Zunahme unter dem Landesdurchschnitt).

PERIODE 1941—1949 (Beilage II)

Diese kurze Periode zeigt infolge des zweiten Weltkrieges in jeder Hinsicht aussergewöhnliche Merkmale. Die Bevölkerung des Landes

vermindert sich während dieser Zeit um 1,1 %, das heutige Budapester Stadtgebiet, das besonders starke Kriegsschäden erlitt, verlor hingegen 7,1 % seiner früheren Bevölkerung.

Das ist der einzige Fall während des untersuchten Jahrhunderts, dass die Einwohnerzahl fast aller Bezirke der Hauptstadt abgenommen hat; in dem Ostsektor konnten erst Gebiete, die mehr als 10 km vom Zentrum entfernt liegen, ihre Bevölkerung in geringem Mass erhöhen. In der westlichen Umgebung der Hauptstadt ist der Rückgang charakteristisch, da dort zahlreiche Dörfer auch in den Jahren nach dem Kriege infolge der Umsiedlung bzw. des Austausches nationaler Minderheiten starke Verluste im Saldo der Migration aufwiesen.

PERIODEN 1949—1960 UND 1960—1966 (Beilage II)

Die Mediankurven der beiden Zeitabschnitte 1949—60 und 1960—66 sind durch grosse Ähnlichkeit gekennzeichnet, so dass man die wichtigsten Züge leicht zusammenfassen kann. Während die Periode 1949—60 in der Einwohnerzahl des Landes eine Zunahme von 8,2 % gebracht hat, wurden zwischen 1960 und 1966 kaum 2,0 % erreicht. Die entsprechenden Werte für Budapest liegen weit darüber (13, bzw. 8,4 %); es kommt das erste Mal vor, dass das *ganze* Gebiet innerhalb der 35 km-Linie über dem Landesdurchschnitt liegende Zuwachsraten aufweist. Der Agglomerationsprozess hat also diese Grenze am Anfang der Periode überschritten. Die Zunahme der Bevölkerung im Einflussbereich der Stadt lässt sich nämlich grösstenteils auf den positiven Migrationsaldo zurückführen. Im Falle von Budapest kommt *ausschliesslich* die Zuströmung ländlicher Bevölkerung in Betracht, weil seit 1957 die Bevölkerung der Hauptstadt keinen Geburtenüberschuss aufweist. Die Sterbeziffern liegen jährlich mit 1 000—2 000 über denjenigen der Geburten (Központi Statisztikai Hivatal 1968).

Im Ostsektor finden wir die höchsten Zuwachsraten in der Entfernungszone 15—20 km, welche ausser dem Bezirk Nr. XVII. der Hauptstadt nur Gemeinden von dörflichem Charakter ausserhalb der Verwaltungsgrenzen von Budapest umfasst. Das hängt mit der rapiden Entwicklung des Pendlerverkehrs zusammen, der mit der zunehmenden Rolle des Busverkehrs jetzt auch den Westsektor erfasst, und den Scheitelpunkt der Kurve auch dort vom Stadtkern weggerückt hat. Dadurch sind die Mediankurven der beiden Sektoren einander mehr ähnlich geworden. Der bedeutenden Entwicklung der Verkehrsver-

hältnisse kann man es zuschreiben, dass der Unterschied der Zuwachsraten von Dörfern mit und ohne Eisenbahnstation wesentlich geringer, und damit die Streuung der einzelnen Angaben auch kleiner wurde.

In der letzten Periode (1960—66) lässt sich eine leichte Abnahme der Einwohnerzahl der innersten Stadtbezirke erkennen, welche auf die stärker ausgeprägten City-Funktionen, und auf einen noch unbedeutenden Rückgang der Bedeutung dieses Gebiets als Wohnviertel zurückzuführen ist, und die als erstes Zeichen der Entvölkerung der Zentrums gedeutet werden kann.

VERGLEICHE UND SCHLUSSFOLGERUNGEN

Man kann aufgrund der Analyse klar *drei grosse Epochen* in der Entwicklung der Bevölkerung von Budapest unterscheiden. Während der zweiten Hälfte des 19. Jahrhunderts stand noch der Stadtkern, vom Ende des Jahrhunderts bis zum zweiten Weltkrieg der industrielle Vorortgürtel an der Spitze der Entwicklung. In der letzten Zeit ist die noch weiter entfernte Zone der Pendler in den Vordergrund getreten. Dabei sei bemerkt, dass in absoluten Zahlen der Gürtel neuer städtischer Wohnanlagen (Entfernungszone 5—10 km) die höchsten Werte der Zunahme der Bevölkerung erreicht.

Die für das untersuchte Gebiet festgestellten Mediankurven (s. Beilagen I und II) lassen sich nach ihrer Form in drei Hauptgruppen teilen (Abb. 1). In der ersten Zeit verhielten sich die Mediankurven wie der Typ *a*, später wurden sie dem Typ *b* ähnlich, schliesslich näherten sie sich immer mehr dem Typ *c*. Die Gebiete mit den höchsten Zuwachsraten haben sich dementsprechend immer weiter von der Stadtmitte entfernt. Im allgemeinen folgt die Entwicklung den Regeln, die Ajo (1961, 1963) in einigen Grossstädten Europas gefunden hat. Die Kurven erinnern in den frühesten Perioden an Kosinuskurven, später aber nähern sie sich einer Sinuskurve an. Obwohl das Maximum der Zuwachsraten mit der Zeit immer ferner von der Stadtmitte erschien, ist es bisher kaum möglich, von einer Entvölkerung des Zentrums in Budapest zu sprechen. Die inneren Bezirke weisen aber tatsächlich immer geringer werdende Zuwachswerte auf, bei einigen ist sogar schon eine leichte Abnahme zu verzeichnen. Aufgrund der Mediankurven kann man deutlich erkennen, dass die schnelle Zunahme der

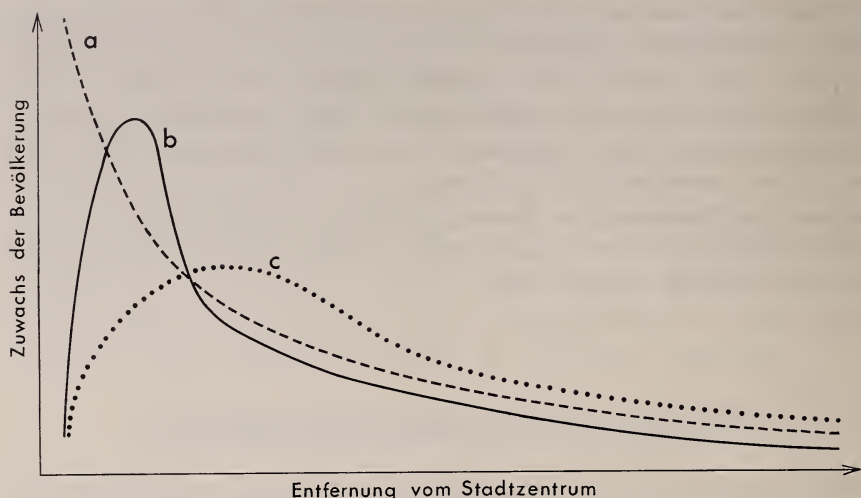


Abb. 1.

Einwohnerzahl in den vom Zentrum beträchtlich entfernten Gürteln auf einen fortdauernden Agglomerationsprozess, nicht etwa auf die Zerstreuung der städtischen Bevölkerung zurückzuführen ist. Der Migrationssaldo der stadtnahen Siedlungen ist wirklich nur der Provinz gegenüber positiv, gegenüber der Hauptstadt aber immer negativ; es gibt noch keine erhebliche Auswanderung aus der Stadt (vgl. Tajti 1962, S. 257). Im Vergleich mit vielen Grossstädten von Nordamerika und Westeuropa vertritt Budapest eine andere Art bzw. eine frühere Phase der Entwicklung. Nach der Untersuchung von Berry *et al.* (1963) könnte Budapests Stelle zwischen den theoretischen Modellen von westlichen und indischen Städten gefunden werden.

Es ist auch bemerkenswert, welche *eigenartigen Gründe* zur beträchtlichen Ausdehnung des Einflussbereiches von Budapest und zur rapiden Entwicklung der Gemeinden in der Umgebung der Stadt beigetragen haben. Zweifelsohne kommt hier in erster Linie der zunehmende Pendelverkehr in Betracht, der sich hauptsächlich aus dem Mangel an Wohnungen in der Hauptstadt selbst erklären lässt. Die Einwanderung und Ansiedelung in Budapest wird auch durch einige administrative Massregeln gehemmt, die ebenfalls eine Anschwellung der stadtnahen, aber ausserhalb der Verwaltungsgrenze liegenden Gemeinden zu Folge haben. Es sind dies keine planmässig erbauten Satellitenstädte, sondern aufgrund des Pendelverkehrs schnell und unregelmässig ange-

wachsene Dörfer, deren äusseres Bild viel weniger als die Berufsstruktur der Einwohnerschaft die grosse Wandlung ihrer Funktion widerspiegelt. Die Ausbildung eines Gürtels von Satellitenstädten wird auch weiterhin als unerwünscht betrachtet (Kóródi und Márton 1968, S. 104), eine gründliche Rekonstruktion der alten stadtnahen Siedlungen, die eine ähnliche Rolle spielen, wird aber wohl unvermeidlich sein. Schliesslich sei auf den merkwürdigen Umstand hingewiesen, dass dem PKW-Verkehr in der Pendelwanderung gegenwärtig noch keine Bedeutung zuzuschreiben ist; der fernwirkende Einfluss der Stadt auf die Entwicklung der Bevölkerung beruht also allein auf den Massenverkehrsmitteln.

Man kann z.T. mit dem Obigen erklären, dass die Mediankurven der Bevölkerungsentwicklung in der Umgebung von Budapest — obgleich sie im wesentlichen mit den Kurven anderer Städte im Einklang stehen — nur langsam ihre Form im Sinne der Tendenz ($a \rightarrow b \rightarrow c$) verändern. Während derselben Periode unterschieden sich die Mediankurven für den Ost- und den Westsektor — besonders früher — stark voneinander. Wenn die beiden Sektoren nicht voneinander getrennt wären, würde es noch schwerer sein, die allgemeine Regelmässigkeit der Mediankurven zu beobachten. Das leitet uns zur Frage hin, wie gut überhaupt die Mediankurven alle Teilgebiete im Budapest-Bereich repräsentieren.

Eine von den merkwürdigsten Erscheinungen an den Diagrammen stellt die grosse Abweichung der Angaben der einzelnen Teilgebiete von den Mediankurven dar. Besonders grosse *Streuung* ist im allgemeinen in den Zonen der höchsten Zuwachsraten zu beobachten; z.B. schwanken während der Periode 1890—1910 in der Entfernungszone 15—25 km die Zuwachsraten zwischen 20 und 200 %. Diese grosse Streuung mahnt zur Vorsicht bei eventueller mathematischer Formulierung der Kurven. Die Mediankurven, die man aufgrund der Mittelwerte für einzelne Entfernungszonen gezeichnet hat, repräsentieren an sich oft sehr schlecht alle Teilgebiete.

In der Nähe des Zentrums war die Streuung jedoch gewöhnlich kleiner. So war es auch bei den äussersten Gebieten, besonders am Anfang der untersuchten Periode. Vor dem ersten Weltkrieg waren diese Gebiete von rein ländlichem Charakter, und die Dörfer folgten noch einem selbständigen Entwicklungsgang, der in den dem Landesdurchschnitt nahen Zuwachsraten zum Ausdruck kommt.

Die zunehmende Streuung der Angaben derjenigen Dörfer, die in den Zuwachszonen des Einflussbereichs der Stadt gelangten, ergibt

sich daraus, dass ihre Entfernung, von der ihre Entwicklung abhängig geworden ist, nach den Verkehrsmöglichkeiten sehr grosse Abweichungen von der Entfernung in der Luftlinien aufwies. Mit der Besserung der Verkehrsverhältnisse, und vor allem mit der Entwicklung des Busverkehrs hat sich der Unterschied der beiden Entfernungen wesentlich vermindert. Das sieht man auch auf den Diagrammen, wo die Streuung in den letzten Jahrzehnten beträchtlich kleiner, und selbst die Asymmetrie der Entwicklung auf der Ost- bzw. Westseite der Donau geringer geworden ist.

LITERATUR

- Ajo, Reino (1944). Tampereen liikennealue. *Publicationes Instituti Geographici Universitatis Helsingiensis*, 1—352.
- » — (1961). On the field profile of the rate of total increase of population, as exemplified by Tampere, Finland. *Acta Geographica* 16: 3, 1—21.
- » — (1963). Fields of population change around the 60th parallel capitals and maritime cities Oslo—Stockholm—Helsinki about 1960. *Acta Geographica* 17: 5, 1—19.
- » — (1964). London's field response II. *Acta Geographica* 18: 3, 1—25.
- Bencze, Imre (1963). A budapesti gyáripár területi elhelyezkedése. *Földrajzi Közlemények* XI/LXXXVII/: 2, 101—129.
- Berry, B. J. L., Simmons, J. W. and Tennant, R. J. (1963). Urban population densities: structure and change. *Geographical Review* 53, 389—405.
- Bertalan, János (1968). *Ujra az ingázásról*. Budapest VI: 10, 32—33.
- Bleicher, H. (1892). *Statistische Beschreibung der Stadt Frankfurt am Main und ihrer Bevölkerung*. Frankfurt am Main.
- Brush, Johan E. (1968). Spatial patterns of populations in Indian cities. *Geographical Review* 58, 362—391.
- Clark, Colin (1951). Urban population densities. *Journal of the Royal Statistical Society*, Ser. A, No. 114, 490—496.
- Haggett, Peter (1966). *Locational analysis in human geography*. 339 S. New York.
- Hult, Juhani (1962). Der Einfluss der Zentren auf die Bevölkerungsdichte ihrer Verkehrsgebiete. *Fennia* 87: 1, 1—49.
- Illyefalvi, I. Lajos (1933). *A székesfőváros multja és jelene*. Grafikus ábrázolásban. 201 S. Budapest.
- Kant, Edg. (1962). Zur Frage der inneren Gliederung der Stadt, insbesondere der Abgrenzung des Stadtkerns mit Hilfe der bevölkerungskartographischen Methoden. *Lund Studies in Geography*, Ser. B, No. 24, 321—381.
- Kóródi, J. und Márton, G. (1968). *A magyar ipar területi kérdései*. 176 S. Budapest.
- Lackó, László (1967). The form and the contents of economic maps. *Tijdschrift voor Economische en Sociale Geografie* LVIII: 6, 324—330.
- Mendöl, Tibor (1963). *Általános településföldrajz*. 567 S. Budapest.
- Newling, Bruce E. (1966). Urban growth and spatial structure: mathematical models and empirical evidence. *Geographical Review* 56, 213—225.

- Palotás, Zoltán (1965). Der Pendelverkehr Ungarns. *Raumforschung und Raumordnung* 23: 4, 222—236.
- » — (1968). Gondolatok a lakóhely és a munkahely távolodásának problematikájáról. *Földrajzi Értesítő* XVII: 2, 257—279.
- Rikkinen, Kalevi (1968). Change in village and rural population with distance from Duluth. *Economic Geography* 44, 312—325.
- Seyfried, Warren R. (1963). The centrality of urban land values. *Land Economics* 39, 275—284.
- Tajti Erzsébet, V. (1962). Budapest munkaerővonzása. *Földrajzi Közlemények* X/LXXXVI/: 3, 255—277.
- » — (1967). A központi iparvidék. A körzethatárolás problémái. *Gazdaságföldrajzi dokumentáció* 6, 17—24.

STATISTIKEN

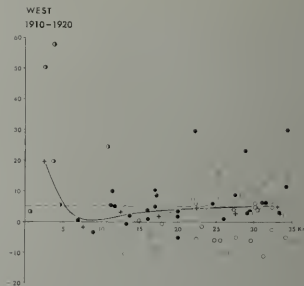
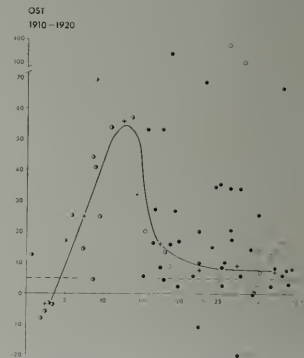
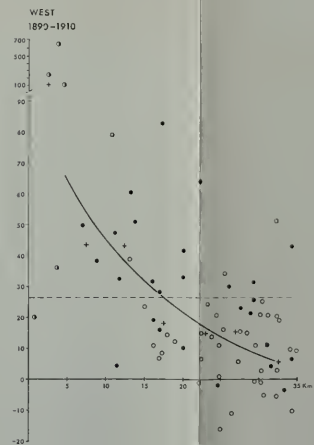
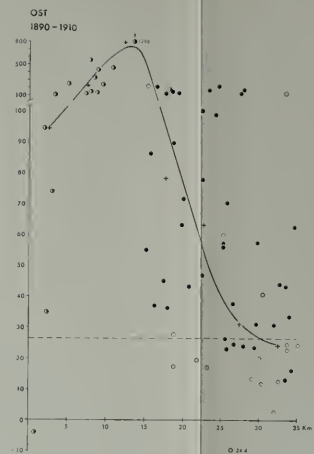
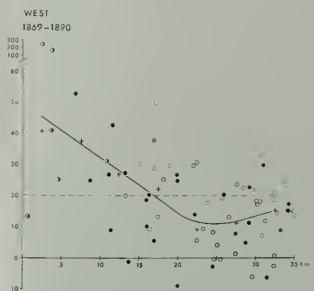
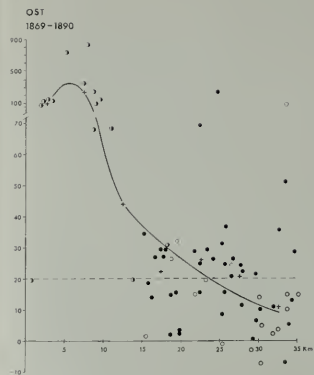
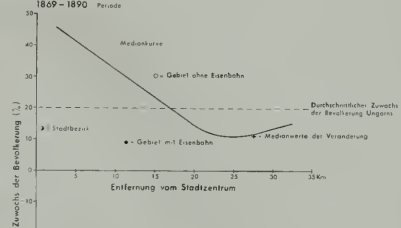
- Központi Statisztikai Hivatal (1961 a). 1960 évi népszámlálás. *Budapest személyi és családi adatai*. Budapest.
- » — (1961 b). 1960 évi népszámlálás. *Pest megye személyi és családi adatai*. Budapest.
- » — (1961 c). 1960 évi népszámlálás. *Fejér megye személyi és családi adatai*. Budapest.
- » — (1961 d). 1960 évi népszámlálás. *Komárom megye személyi és családi adatai*. Budapest.
- » — (1967). *Megyei statisztikai évkönyvek*. Budapest.
- » — (1968). *Budapest statisztikai évkönyv*. Budapest.

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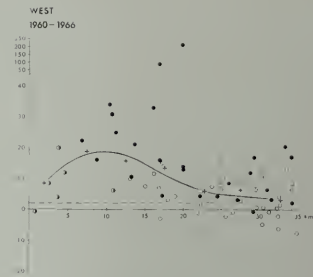
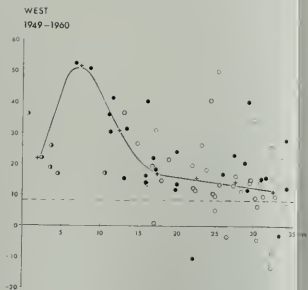
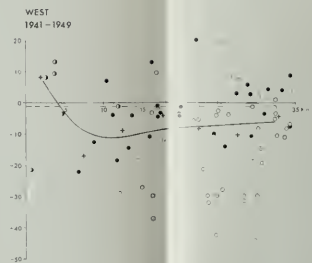
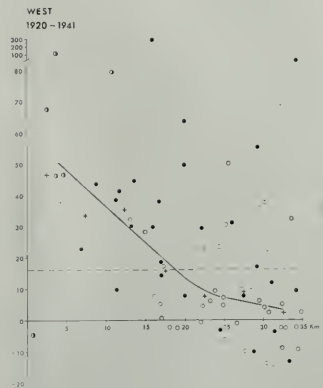
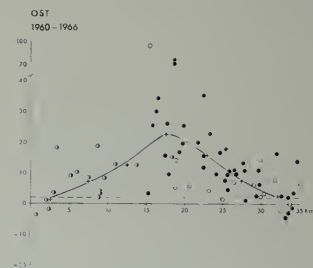
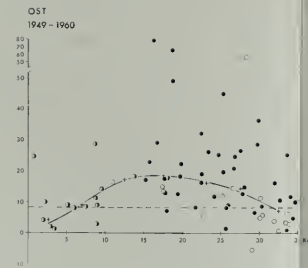
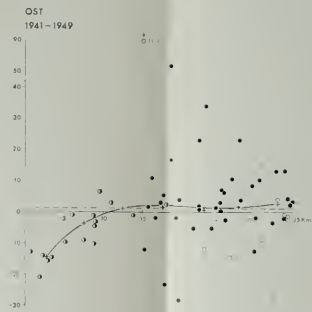
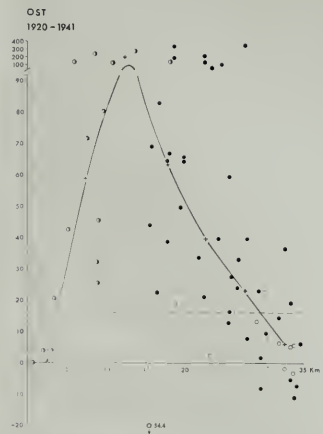
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ZEICHENERKLÄRUNGEN

OST = Gebiete östlich von der Dänau
WEST = Gebiete westlich von der Dänau
1869 - 1890 Periode



(Zeichenerklärungen
siehe BEILAGE I)



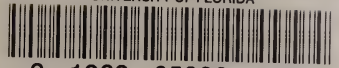
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